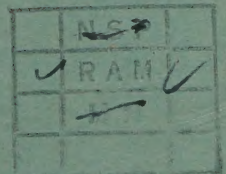




COLONY AND PROTECTORATE OF KENYA

**DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
1957**

Volume II—Record of Investigations



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ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1957

Headquarters at the Scott Agricultural Laboratories dealt with administration, general investigations, advisory work, insect identification and the plant protection services. The Entomologist at Nakuru dealt with pests of high altitude crops, the Coast Entomologist at Matuga dealt with pests of coconuts, cereals and cotton, while the Entomologist at Kibos worked on pests of cotton and other crops growing in Nyanza.

Plant Protection

NEW LEGISLATION

The Plant Protection (Import Control) (Amendment) Order, 1957 (Legal Notice No. 521), was introduced and replaced the *Plant Protection (Import Control) Order, 1937* (Government Notice No. 688). The East African Standing Technical Committee on Plant Import and Export, Muguga, introduced a new schedule in order that rules appertaining to the importation of plant material should be the same for all East African territories. *The Agricultural Produce (Horticultural Produce Inspection) Rules, 1957* (Legal Notice No. 194 of 1957), were brought into force in order to ensure that fresh fruits and vegetables for export were of a high standard.

IMPORTATION OF PLANTS

During the year a total of 1,812 plant importation permits were issued, showing a slight reduction over the previous year's figure which was 1,841. Plant importation permits, which normally were issued for onions, were severely cut due to the Department of Trade and Supplies restricting their importation. Parcels imported through the Post Office and inspected at the Scott Laboratories numbered 2,520, showing a decrease of 234 over last year's figure. Over 10,000 packages were inspected at Eastleigh Airport, the greater proportion of this figure representing importations of fresh fruits from South Africa. In addition to the above, horticultural produce in the form of fresh pineapples and vegetables was inspected for export to the United Kingdom and Mogadishu respectively. Visits were also made to Nairobi West Aerodrome, the Railway Station and the General Post Office. Revenue collected from fines amounted to Sh. 792.

EXPORT OF PLANTS

The number of export certificates issued during the year was only 229, a marked decrease from the 1956 figure of 574. This was due to the alteration in the regulations which permitted free movement of plant material, with the exception of coffee, sisal, Mauritius hemp and bananas, between the East African territories.

FUMIGATIONS

Very few fumigations were carried out on plant material for export, this being mainly due to the fact that Tanganyika no longer requires plant material exported from Kenya, to be fumigated before despatch. A large consignment of apples, which arrived by road from South Africa, was found to be infested with red spider mite and was subsequently fumigated with ethylene dibromide prior to being released. Methyl bromide fumigation was used on other stored products.

INSECTS INTERCEPTED

The following insects were intercepted:—

Laemophloeus sp. (Cucujidae), South Africa, sorghum alium; *Enzophera sagax* Meyr (Lepidoptera), Nyasaland, tea seed; *Bruchus rufimanus*

(*Bruchidae*), Italy, beans; *Lepidosaphes beckii* (*Coccoidea*), Italy, citrus fruit; *Drosophila* larvae (*Drosophilidae*), South Africa, grapes; *Tetranychus* sp. (*Tetranychidae*), South Africa, apples; and *Chrysomphalus pinnulifer* (*Coccoidea*), Madagascar, orchids.

VISITS

Mr. Duncan visited the United Kingdom from 13th to 31st August, 1957, to study the marketing of pineapples and other fresh fruits exported from Kenya. As a result of this visit, arrangements were made with the Covent Garden Laboratory, London, to carry out trials on our behalf with fresh pineapples at various stages of ripeness and varying cool storage conditions. This work will enable us to advise exporters of the best way to send fresh pineapples to the United Kingdom by sea.

STAFF

Mr. H. Wilkinson joined the staff as a Plant Inspector on 8th July, 1957.

Thanks are given to the staffs of the Customs and Excise Department and the General Post Office for their helpful co-operation. Thanks are also given to the staff of East African Airways Corporation for all their help throughout the year.

Stored Products

The Pest Infestation of Stored Products Committee held three meetings during 1957.

Mr. W. M. Graham joined the staff in January, 1957, as Stored Products Entomologist (Maize Control), and with Mr. S. Kockum, Scientific Officer (Stored Products), was stationed at the Scott Agricultural Laboratories during the year.

They report as follows:—

A long series of experiments was begun in collaboration with the Pest Infestation Laboratory, Slough, England on fumigation with methyl bromide under gasproof sheets. Mr. H. K. Heseltine, Senior Experimental Officer of the Fumigation Section at Slough, came to Kenya at our request to advise and initiate these experiments. Nine experimental stacks have been studied, using the gas-sampling technique, during the year. About 1,000 gas samples have been analysed for methyl bromide content. These experiments, which are to be continued, have already shown that satisfactory results can be obtained in fumigating large stacks, have given useful information about gas penetration and distribution and have already resulted in economies in practised application.

Following a report from England of successful fumigation of malt in polyethylene-lined bags, an experiment was carried out using maize in such bags in a gas chamber. The penetration of methyl bromide through polyethylene was confirmed. With a fumigation time of 48 hours and using liners of not more than 0.025 in. thickness good results should be obtained with 2 lb. of methyl bromide per 1,000 cu. ft. at temperatures greater than 20° C.

An experiment with cob maize held in a crib for 13 months corroborated our earlier finding that cob maize dusted with 0.06 per cent gamma B.H.C. (Lindane) in local diatomite, at a rate of 8 oz./ 9 cu. ft., kept virtually without insect damage for over a year when the crib walls are covered with hessian, sprayed at the time of storing with 40 gm. Lindane plus 4 gm. coumarone resin dissolved in kerosene, at the rate of 1 litre per 100 sq. ft. This method may be useful when cob maize for rations or stock feed has to be stored on farms for more than six months. The standard practice in Kenya is to dust cob maize

after harvest with 0.5 per cent Lindane in diatomite (8 oz./9 cu. ft.) when stored in cribs with open wire-netting walls. This treatment gives almost perfect results for six months, but after 13 months about 20 per cent damage was found in this year's experiment. Untreated maize had over 90 per cent damaged grain.

An insect population study with different treatments of shelled maize in 200-lb. bags, carried out over 33 months, showed spectacular results with admixture of 0.3 per cent pyrethrins plus 3 per cent piperonyl butoxide in finely milled pyrethrum marc. At 8 oz. per 200-lb. bag the population was kept down to an extremely low level as long as the experiment lasted. At 4 oz. the treatment was equal to one part per million of gamma B.H.C. This experiment was carried out in a store with a very heavy infestation and where no specially cold season occurs.

A large-scale stack experiment was laid down in 1956. Four stacks, each containing about 3,000 200-lb. bags of white maize were built. Two of the stacks were surface dusted, layer by layer, with 0.5 per cent Lindane-diatomite powder at the rate of 3 oz. per bag. The other two stacks were sprayed with 1.5 lb. D.D.T. per 1,000 sq. ft., layer by layer. One stack of each treatment stood on dunnage and the floor was treated with 10 per cent D.D.T. dust. The other two stacks stood on untreated floor. The stacks were fumigated with methyl bromide at the beginning of the experiment. After 13 months the maize was found to be in very good condition and pest infestation in all four stacks was small and mostly confined to the upper parts of the stacks. *Tribolium castaneum* and *Oryzaephilus surinamensis* were present but *Calandra oryzae* was absent. A statistical analysis could not establish any difference between the floor treatments. B.H.C. dust was better against *Tribolium* than D.D.T. spraying.

Tribolium was responsible for the increase in temperature which occurred. *Oryzaephilus* showed signs of being more sensitive to D.D.T. than to B.H.C.

Trogoderma granarium infestations were found on a number of ships arriving at Mombasa and were dealt with by fumigation. In two early cases infested products slipped through inspection. A brewery at Mombasa was found to have infested malt. Also yellow gram from India was found to be infested after importation. In both cases fumigation and, where necessary, spraying, was undertaken and it is believed that these infestations were successfully eliminated.

Mr. S. Kockum, Scientific Officer (Stored Products), represented Kenya at a conference held in Salisbury, Southern Rhodesia, in February by the Scientific Council for Africa South of the Sahara (Specialist Meeting on Stored Food Products). Two papers were delivered at the conference: "The Control of Stored Products Insects in Kenya" by R. H. Le Pelley and S. Kockum, and "Storage of Maize on the Cob in Kenya" by S. Kockum.

Pests of Agriculture

Mr. J. F. Graham, Entomologist, Scott Agricultural Laboratories reports as follows:—

The planting programme for cotton in Nyanza was supervised in the absence on leave of Mr. Crowe.

At the Mwea Irrigation Scheme the investigation into rice stem borer, *Rhinaphe vectiferella*, continued and a trial was laid down to control it. This was carried out as a co-operative experiment by the Agricultural Officer (Irrigation Research). The seedlings in the nursery were dusted twice with B.H.C. and, after transplanting, were then given three sprayings with endrin at intervals of 12 days. At harvest the number of borers per plant showed a significant drop

from 14 to nine but the reduction of empty heads from 18 per cent to 12 per cent was not significant, nor was the difference in yield. The experiment will be repeated with earlier application of endrin since it would appear that the infestation was already heavy when the spraying took place.

A large-scale ant and mealybug control experiment on pineapples was laid down at Thika Horticultural Station. Treatments for planting material were:—

- (1) Dipping for five minutes in 0.05 per cent Diazinon.
- (2) Fumigation by 2 lb. per 1,000 cu. ft. of methyl bromide.
- (3) No treatment.

Ant control measures were:—

- (1) 4 lb. of actual D.D.T. per acre followed one month later by 2 lb. of actual D.D.T. followed a month later by 2 lb. of actual D.D.T. A 25 per cent D.D.T. emulsion was used in 50 gallons of water per acre.
- (2) Dieldrin at the rate of 12½ oz. of actual dieldrin per acre in 50 gallons of water followed later by spot treatment of ant infestations by the same material in a knapsack sprayer.
- (3) No treatment.

Indications at the end of the year were that further work is necessary on methyl bromide fumigation rates, and also on ant control measures.

Insecticidal trials on other insects, together with visits to other areas and general advisory work, were carried out.

Mr. P. E. Wheatley, Entomologist, Coast Province, reports as follows:—

THE COREID BUG OF COCONUT (*Pseudotheraptus wayi*)

Work on the biological control of this pest has so far proved unsuccessful. The predatory tree-nesting *Oecophylla* which, when present in large numbers, effects considerable control of the Coreid bug, has not increased in numbers in a three-acre block from which all antagonistic ants were eliminated for a period of a year by insecticidal treatments. It is possible that under Kenya conditions *Oecophylla* populations are limited more by food availability than by antagonistic ants.

Insecticidal work against the Coreid has consisted of small hand-spraying experiments on a semi-isolated block at Gazi. Dieldrin has shown some promise at high concentrations, with a good residual kill. Bio-assay work has been started at Matuga where, after many initial difficulties, the Coreid bug is now being bred in fair numbers. Chemical analysis of surface and absorbed deposits of D.D.T. following applications of different formulations is being undertaken in connexion with the bio-assay work and with the co-operation of Long Ashton Research Station, Bristol.

ECONOMIC IMPORTANCE OF COTTON PESTS

A trial was carried out near Gede to assess the loss in yield and quality of cotton which can be attributed to the major insect pests of this crop. It was estimated that American, Pink and Spiny bollworms together reduced the yield by 600 to 700 lb. seed cotton per acre. Cotton stainers were found to be responsible for a considerable reduction in quality, and the reduction in value of the crop, due to all insect pests, was found to be in the region of Sh. 400 per acre under the good husbandry conditions of the experiment and with the adequate rainfall experienced this year. Treated plots yielded an average of 1,295 lb. seed cotton per acre.

ECONOMIC IMPORTANCE OF COASTAL MAIZE STEM BORERS

A trial to determine the loss of yield in maize due to *Chilo zonellus* and *Chilo traea argyrolepis* was carried out at Matuga. Very poor growth gave low yields from all plots, and although yields were significantly higher where stem borers were controlled, further work is required before a definite conclusion can be reached.

SWEET POTATO WEEVILS (*Cylas puncticollis*)

Single and double application of two pints of an emulsion containing 19.5 per cent endrin in 160 gallons of water per acre, two months (single) and two and four months (double) after planting, did not give a good control of this pest. Similar treatments were tried against an unidentified clear-wing moth, the larvae of which bore in the tubers and vines of sweet potatoes. Only partial control was achieved against this new pest and this treatment cannot be recommended to the grower.

CASTOR OIL DIE-BACK

An investigation is being made into the die-back of castor oil inflorescences which is prevalent in the wetter areas of the Coast. Many species of *Hemiptera-Heteroptera* have been collected from inflorescences in the field but none have yet been shown to induce die-back. One, *Acrosternum acutum*, causes abortion of immature seed pods but it is not reckoned to be a serious pest. Dieldrin sprays did not successfully control die-back in experiments at Shimba Hills and near Gede and, in fact, led to a reduction in yield.

Mr. T. J. Crowe, Entomologist, Nyanza Province, reports as follows:—

Owing to my prolonged absence from the Province only a limited programme was attempted this year and only cotton experiments were planted. The full results of last season's cotton trials will appear in the Empire Cotton Growing Corporation's "Progress Reports from Experiment Stations—Kenya, 1956/57".

In the Lake Shore Luo area stainer numbers were generally below average.

On the Kibos Pest Assessment Trial, yields were very poor owing to prolonged waterlogging early in the year. The proportionate losses due to the various pests were, however, of the same order as last year.

	Yield/acre
All pests controlled	610 lb.
Boll-shedding pests controlled	324 lb. (54 per cent stained).
Stainers only controlled	256 lb.

Pink bollworm, *Platyedra gossypiella*, was very common in late maturing bolls.

At 20 sites scattered through the Lake Shore area of Central and South Nyanza a single replicate of a dusting trial was planted. The treatments were:—

- (a) 80 lb./acre 3:10:0 cotton dust, 3 per cent gamma B.H.C./10 per cent D.D.T. (5 × 16 lb. at ten-day intervals).
- (b) 80 lb./acre 10 per cent D.D.T. dust (5 × 16 lb. at ten-day intervals).
- (c) Untreated.

Picking is still in progress but already (a) plots have given an average of over 900 lb. seed cotton/acre, largely unstained, compared with 400 lb., with a high percentage stained, on the controls. The D.D.T. treatment has given very variable results. This is the third successive season that 3:10:0 cotton dust has given satisfactory yield increase in this area and next season the dust will be on sale and extension work will begin on a limited scale.

Dusting trials have, up to now, been planted about 1st April on tie-ridged plots. An experiment was planted at Kibos to find out if anything was to be gained by planting on 1st March or anything to be lost by planting on the flat. The highest yields came from plots planted on 1st March on the flat but there were only small differences in the yields and all produced over 1,000 lb. seed cotton/acre.

Three kaolin-based 3:10:0 cotton dusts were tested for persistency under field conditions. One was the standard formulation; the other two contained different oil stickers. Daily *Dysdercus* counts produced no evidence that the formulations with stickers were superior to the standard dust.

In the region next to the Uganda border, *Lygus*, the chief pest of this zone caused much more damage than usual.

Trials of the spraying method developed in Uganda were made. Four sprays each of 1 lb. D.D.T. in eight gallons of water were applied at ten-day intervals. The spray was directed at the top few leaves, no attempt being made to wet the whole plant. Twenty peasant plots were treated leaving 20 others as controls. Leaf damage has been greatly reduced on the sprayed plots and boll counts suggest that the yield will be doubled, but picking is not yet complete.

Other trials in this zone are designed to find out the best protection period for cotton planted in April, May and June.

Work began on the possible insect vectors of passion fruit woodiness virus. A lightweight cage which encloses 10.4 sq. cm. of leaf surface but weighs only 5 grams has been devised. Of the few aphid species tested to date only *Aphis gossypii* feeds freely on passion fruit. Transmission experiments on this and other polyphagous species will begin early in 1958.

Harvesting of the sweet potato experiment reported last year was completed. Control of *Achraea acerata* caterpillars with 0.02 per cent chlordane and 0.2 per cent endrin gave yields of 4,574 lb. and 4,792 lb. respectively compared with 2,505 lb./acre on the control. Potatoes from treated plots were of markedly superior quality.

The banana weevil, *Cosmopolites sordidus*, was recorded for the first time in Kericho District. It was accidentally introduced in infested planting material. Vigorous efforts are being made to stamp it out before it spreads.

Considerable areas of newly-transplanted rice on the Kano Plains, Central Nyanza, were attacked by a shoot-boring maggot, the larva of a diopsid fly. This pest will be further investigated in 1958.

Mr. J. A. Bullock, Entomologist, Rift Province, reports as follows:—

The majority of experiments have been concerned with barley fly, *Hylemyia arambourgi*. Work has also been done on pyrethrum thrips, *Thrips tabaci*, larvae of the Curculionid *Nematocerus*, and on possible phytotoxic effects of D.D.T. and dieldrin.

BARLEY FLY (*Hylemyia arambourgi*)

Aldrin and dieldrin dry seed dressings were tested and gave good control of the fly. Trials with a dressing of 50 per cent endrin and an aldrin/organo mercurial dressing showed promise but gamma B.H.C. gave no control. Spray trials indicated that dieldrin and endrin, at 8 to 9 oz. active ingredient and 6 oz. active ingredient respectively, gave some control. Aldrin spray had some effect but diazinon spray was less effective. Aldrin, gamma B.H.C. and dieldrin wettable powder, at rates of 8 oz. active ingredient per acre in all cases, were tested as pre-planting sprays. In no case was a reduction of infestation noted.

Six varieties of barley, Kenia, Carlsberg, Herta, Prior, Research and No. 5 were tested for varietal susceptibility but no apparent differences occurred.

Larvae morphologically identical to those of *H. arambourgi* were recorded on Kikuyu grass (*Pennisetum clandestinum*).

MAIZE STALK BORER (*Busseola fusca*)

Only light infestations occurred on farms where experiments were projected, and these have been postponed until next year. A trial of sorghum varieties for susceptibility to attack was late in showing an infestation, but a count on 8th November revealed a 50 per cent infestation of all shoots. There appeared to be little difference in the susceptibility of the different varieties.

HETERONYCHUS spp.

A trial with three levels of gamma B.H.C./organo mercurial seed dressing on an Italian ryegrass ley was abortive as the insect did not appear. A pronounced phytotoxic effect with the highest level of dressing at 6 oz. per 10 lb. seed per acre was noted.

PYRETHRUM THRIPS (*Thrips tabaci*)

Much trouble has been caused by this pest in many of the pyrethrum-growing areas. In most cases, two sprays of D.D.T. at fortnightly intervals have proved effective, but on one or two occasions there have been failures. Trials have been commenced with various insecticides, but positive results have not so far been obtained. The trials have shown that diazinon, malathion and pyrethrum are not effective. In a later experiment dieldrin spray gave satisfactory control when applied at 7.5 oz. active ingredient per acre.

CABBAGE SAWFLY (*Athalia* sp.)

Damage, sometimes very severe, has been caused to various fodder crucifers by larvae of *Athalia* sp. In most cases D.D.T. gave control, although in one case, where control had not been achieved with two applications, a spray of dieldrin containing 7.5 oz. active ingredient per acre had to be used, and was satisfactory.

PHYTOTOXICITY

In two trials at Eldoret the effect of hand application of D.D.T. on maize was examined. The rate of dilution of 1 pint of 25 per cent D.D.T. per acre was varied in one experiment, and in the other the rate was kept constant at 30 gallons per acre and the quantity of D.D.T. varied. Very slight scorch was noted at the highest rates in each, i.e. 1 pint in 15 gallons water and 2 pints in 30 gallons water (0.1 per cent solutions in each case). At Ol Joro Orok small plots of barley were sprayed with varying rates of endrin up to 3 pints in 30 gallons per acre (0.23 per cent). No signs of scorch could be found after 14 days.

NEMATOCERUS sp.

Severe attacks by an adult weevil in May and June were satisfactorily controlled by the use of B.H.C. bait, D.D.T. or dieldrin sprays. Isolated attacks by larvae were noted during the same period, but the importance of the pest was not appreciated until November when some 400 acres of cereals were attacked at Naro Moru. The injurious populations are of the order of one or two million to the acre. Various treatments, notably aldrin, B.H.C., and dieldrin seed dressings, chlordane, dieldrin, ekatin and endrin sprays, and aldrin and dieldrin sprays followed by harrowing, have failed to give any appreciable control. Work is now in progress on the life cycle, and on other control methods in box experiments.

ARGYROSTAGME NIOBE

A little damage was caused by this insect and by the closely related *Dasychira georgiana* Fawcett. Work on the life cycle of both species has continued during the year.

Mr. G. De Lotto, Entomologist (Taxonomy), reports as follows:—

The second paper of the series dealing with the redescription and revision of the Ethiopian mealybugs (*Pseudococcidae*) has been completed and sent to the press. In it are treated the species described by C. K. Brain from South Africa. A third paper covering sundry species from various parts of Africa south of the Sahara was begun.

The redescription and critical revision of coccid genera which include species of economic importance has been continued. A study of the species of genus *Coccus* is nearly finished. A critical review of the genus *Ceroplastes* is under way, and it is hoped to extend this work to all African species and present the final conclusion as a monograph of the genus.

Work has also begun on a statistical analysis of populations of epigeic and hypogeic specimens of *Planococcus citri*. A number of new coccids are being described for the first time.

Literature

Further progress was made on the compilation of recorded information on the Agricultural insects of East Africa. At the end of the year it seemed likely that a complete draft might be ready some time in 1958.

The entomological part of the Assistant Agricultural Officer's Handbook was completed and fuller details of pest control were incorporated in "Insect Pests of Agriculture in Kenya" for the use of District Agricultural Officers.

Advisory Leaflets

The following subjects were dealt with:—

- (1) Maize Stalk Borer (*Busseola fusca*).
- (2) Barley Fly (*Hylemyia arambourgi*).
- (3) Wattle Caterpillar (*Argyrostagme niobe*).
- (4) Pests of Crucifers.

Publications

De Lotto, G.—

Notes on some African species of Saissetia (*Homoptera: Coccoidea Coccidae*), *J. Ent. Soc. Sthn. Africa*, 20, 170-182.

New Aspidiotini (*Hom. Coccoidea, Diaspididae*), from Kenya. *Ann. Mag. Nat. Hist.* (12), 10, 225-231.

The Pseudococcidae (*Hom. Coccoidea*) described by H. C. James from East Africa. *Bull. Brit. Mus. (Ent. Ser.)*, 5 (5), 185-232.

On Some Ethiopian Species of the Genus *Coccus* (*Hom. Coccoidea Coccidae*). *J. Ent. Soc. Sthn. Africa*, 20, 295-314.

Graham, J. F.—

Pineapple Wilt is insect caused. *E.A. Farmer and Planter*, February, 1957.

Destruction of Termite Nests. Coffee Board of Kenya Monthly Bulletin, March, 1957.

Insect Pests of the Garden. *Gardening in East Africa, Fourth Edition*, pp. 367-375.

Crowe, T. J.—

Progress Reports from Experimental Stations, Kenya, 1956/57. Empire Cotton Growing Corporation.

Kockum, S.—

Storage of Maize on the Cob in Kenya. C.S.A. Congress in Salisbury, Rhodesia.

Le Pelley, R., and Kockum, S.—

The Control of Stored Products Insects in Kenya. C.S.A. Congress in Salisbury, Rhodesia, 1957.

Acknowledgments

The essential help of the Commonwealth Institute of Entomology with special reference to the identification of insects is once again acknowledged with pleasure.

R. LE. PELLEY,
Senior Entomologist.

ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST, 1957

As in previous years, the advisory work has necessitated a certain degree of minor research work in order to diagnose the variety of plant diseases encountered. The proportion of problems of this nature tends to increase while the total number shows a falling off. This is accounted for, apart from seasonal variation, by the fact that the more frequently occurring diseases are now well enough known, in particular by departmental officers, many of whom now find it necessary to send in only the less easily recognized diseased material. A certain amount of advisory work is diverted from the laboratory by the travelling technical representatives of the three main distributors of fungicides in the Colony. During the year, 392 specimens of diseased material were dealt with, 156 of these being from departmental officers and 236 from the public. In connexion with plant disease problems, 89 visits were paid to the pathological laboratory.

The disease position in general followed the usual pattern as regards the species of fungi recorded. There was, however, some variation in the severity and incidence of one or two major diseases following abnormal weather. Potato blight, *Phytophthora infestans*, occurred in February for the first time on record. Cigar end rot of banana fruits, *Stachylidium theobromae*, was widespread and severe during the same period in the Highlands East of the Rift. "Crown rot" of strawberry, caused by *Rhizoctonia solani*, appeared in widely separated localities and exceptionally heavy attacks of rust, *Uromyces phaseolorum*, occurred on French beans. One of the most serious and widespread diseases of potatoes, especially in African areas, was the bacterial blight, *Pseudomonas solanacearum*. *Fusarium graminearum* was the cause of an almost total loss of seed from a crop of Rhodes grass. A widespread disease of Russian comfrey was caused by *Pleospora herbarum*. *Armillaria mellea* was the cause of increased losses in tea plantations and nurseries in the African areas of Mount Kenya and there was some evidence of the failure of ring barking shade and forest trees as a preventive measure in the Kericho District.

The following new diseases were recorded during the year: *Pseudomonas delphinii* on delphinium, *Mycosphaerella brassicicola* on Brassicae, *Colletotrichum lagenarium* on melon, *Cryptosphaerella viticola* on vine and *Pleospora herbarum* on Russian comfrey. The "leaf eelworm of chrysanthemum", *Aphelenchoides ritzema-bosi*, was recorded on chrysanthemum and pyrethrum.

Diseases of vegetable crops included *Cercospora citrullina*, *Pseudoperonospora cubensis* and *Erysiphe cichoracearum* on cucumber; *Erysiphe polygoni*, *Ascochyta pisi* and *Mycosphaerella pinoides* on peas; *Uromyces phaseolorum*, *Synchytrium dolichi*, *Colletotrichum lindemuthianum* and *Pseudomonas medicaginis* f. sp. *phaseolicola* on French beans; *Uromyces fabae* and *Botrytis fabae* on broad beans; *Septoria apii-graveolentis* on celery; *Alternaria brassicae* and *Mycosphaerella brassicicola* on cabbage and cauliflower; *Phytophthora infestans*, *Septoria lycopersici*, *Alternaria solani*, *Cladosporium fulvum*, *Pseudomonas solanacearum* and *Phoma* sp. on tomatoes.

Diseases of fruit crops included *Venturia inaequalis* and *Coniothecium chomatosporum* on apple; *Plasmopara viticola*, *Uncinula necator* and *Cryptosporella viticola* on vine; *Armillaria mellea* on plum and *Puccinia pruni-spinosae* on plum and peach; *Monilia fructigena* on imported cases of plum, apricot and peach; *Stachylidium theobromae* on banana; *Thielaviopsis paradoxa* on pineapple; *Septogloeum mori* on mulberry; *Rhizoctonia solani* on strawberry; "Crown Gall" on youngberry; *Septoria rubi* on boysenberry and raspberry; *Colletotrichum lagenarium* on melon.

On grass and fodder crops there occurred *Helicobasidium purpureum*, *Rosellinia necatrix*, *Pseudopeziza medicaginis*, *Peronospora trifoliorum* on lucerne; *Cystopus tragopogonis* and *Sclerotinia sclerotiorum* on sunflower; *Fusarium* sp. wilt on pigeon pea; *Pleospora herbarum* on Russian comfrey; *Claviceps purpurea* on *Paspalum dilatatum*; *Sphacelia* and *Cerebella* sp. on *Bothriochloa insculpta*; *Fusarium graminearum* on *Chloris gayana*; *Helminthosporium cynodontis* on *Cynodon* sp. and *Beniowskia sphaeroidea* on *Pennisetum clandestinum*, *P. purpurea* and *Setaria sphacelata*.

The following diseases occurred on ornamentals: *Septoria dianthi*, *Uromyces dianthi*, *Heterosporium echinulatum* on carnations; *Botrytis gladioli* and *Uromyces gladioli* on gladiolus; *Diplocarpon rosae*, *Cercospora rosicola*, *Sphaceloma rosarum* and *Sphaerotheca pannosa* on roses; *Stigminia palmivora* on palms; *Alternaria zinniae* on zinnia; *Heterosporium gracile* on iris; *Pseudomonas delphinii* on *Delphinium* and Mosaic virus on lily.

On cereals there was *Puccinia graminis*, *P. glumarum* and *P. recondita*, *Ophiobolus graminis*, *Erysiphe graminis*, *Helminthosporium sativum*, *Ustilago tritici* and *Septoria nodorum* on wheat; *Puccinia graminis*, *P. Glumarum* and *P. hordei*, *Helminthosporium teres* and *H. sativum* on barley; *Helminthosporium avenae* on oats and *Helminthosporium sativum* on rye; *Puccinia sorghi*, *Helminthosporium turcicum*, *Sphacelotheca reiliana*, *Diplodia zeae* and *Fusarium graminearum* on maize.

Potato Production

A further collection of hybrids from the Scottish Plant Breeding Station was kindly supplied by Dr. Black. It consisted of four differentials for the identification of races of blight and the seedlings 1899 d4, 2200(21), 2314 a(3), 2320 b(2), 2329 a(3) and 2341 a(5). Two crops of these have been grown. From Northern Ireland, the new varieties, Ulster Torch, Ulster Tarn, Ulster Beacon and two seedlings, E165 and F95 have been kindly supplied by the breeder, Mr. John Clarke. Small lots of Arran Pilot, Ulster Premier, King Edward, Majestic and Epicure were obtained through the courtesy of Sir. T. A. Wedderspoon and a collection of blight-resistant potatoes from Mexico through the Rockefeller Foundation as part of a co-operative scheme for the study of blight races in different parts of the world. A consignment of 30 kilos of nine varieties were kindly supplied to the Department by the Institute of Research on Varieties of Field Crops of the Netherlands.

Wheat Rust

The work on stem rust of wheat has again been centred on the Scott Laboratory and further progress has been made towards establishing it on a firm basis before again transferring this activity to the Plant Breeding Station at Njoro. The main task has been to reisolate as many as possible of the rust races. The work has been complicated by the impurity of some of the differential varieties, which themselves have had to be separated out by means of their reactions to rust, and a supply of seed built up. A "double leaf" inoculation has been used for the observation of the reactions of two rusts under comparable conditions. The first and second leaves of a seedling are inoculated with each rust respectively and each test is duplicated with the position of the rusts reversed. The method has been of value when a mixture of two rusts in one collection is suspected and for comparing a known with an unknown.

During the year, 74 rust collections were received for identification and by the end of the year 51 of these tests had been completed. From these, five races, Nos. (11), (12), (13), (14), and (16), were reisolated and maintained in

culture, and, in addition, three suspected new races, bringing the total number of races identified up to 19. The general position with regard to the identity of the races and in particular the acceptance of new races must be treated with some reserve until the confusion over the differentials has been resolved. In view of this and of the number of foreign wheats now incorporated in the breeding programme, it seems clear that full reliance can no longer be placed on the local differentials nor do they enable a comparison to be made of similar work done in other parts of the world. It has been decided to exploit fully the range of international differentials while retaining the local differentials for the separation out of any local sub-races.

The three new races (17), (18), and (19), were widely distributed throughout the Colony and have probably been built up during the past two or three years when little testing was done. As in 1956, the most common rust was 16, occurring 17 times out of a total of 51, this was followed by 18, one of the "new" rusts which was found 11 times. No rust designated earlier than 11, which occurred once, has appeared.

With the re-establishment of the races in culture at the Scott Laboratories, it has been possible to resume screening of the Plant Breeder's selections against five of the races, namely (11), (12), (13), (16) and (17). Altogether, 125 selections were so tested. Of these, three failed to germinate. Of the remainder, five were susceptible to all five races, eight to race 4, ten to race 3, 22 to race 2, and 28 to race 1. Forty-nine were resistant to all five races.

As in the past, the isolated rust races have been maintained on plants growing to maturity and inoculated at a comparatively early stage by injection. Since the Scott Laboratory is remote from the wheat-growing areas, chance infections from outside are rare and it has been possible to grow small plots of the susceptible differentials and produce seed without the attacks of rust which normally assail them when grown on the Plant Breeding Station.

Legume Bacteriology

Staff shortages during the year were responsible for the work being reduced to a minimum. All investigational work was suspended and activities were confined to the maintenance of master cultures and the preparation of inoculant for distribution to the public. A total of 316 orders for inoculant were received during the year, but many of these involved inoculant for several different legume species. The analysis of orders is as follows:—

LEGUME	No. of Orders	No. of Units of Inoculant	Pounds of Seed
Lucerne	183	457	9,140
Indigenous Clovers	143	263	5,260
Exotic Clovers	70	109	2,180
Lupin	49	571	22,840
Soya	22	56	2,240
Pea, Vetch	13	44	1,760
Serradella	13	38	760
Cowpea and Tropical Spp. ..	14	30	600

These orders include 23 from Tanganyika, 12 from Uganda, two from the Rhodesian Federation and two from Nigeria. Of the 1,568 units of inoculant despatched, 1,104 were for members of the public and 464 for various Research and Government Institutions.

Seed-testing Laboratory

The number of samples received for testing showed an increase of 560 over the preceding year, being 2,130, and consisted in the main of cereals, vegetable, grass and legume seeds. A large number of samples came from seed firms who wished to have their stock tested at regular intervals. Departmental tests included tests of grass seeds from experimental plots from the District Agricultural Officer, Kakamega; the Pasture Research Officer, Molo; the Senior Pasture Research Officer, Kitale, and monthly tests of cotton-seed from the Coast in a storage test.

Germination tests on barley and maize were done for a chemical manufacturing company to assist in arriving at the correct dosage of mercurial seed-dressing and on coffee seed for the E.A. Industrial Research Organization in connexion with the artificial drying of coffee. *Digitaria scalarum* seed was tested for the Pasture Agronomist, Uganda. The optimum temperature for this seed was found to be 32° C. A number of tests were made on a wide range of crops in connexion with Agricultural Shows and the Annual Maize Competition.

There is increasing evidence of the deterioration of germination capacity of seed when retained or in transit at the Coast. Flower seed in transit from Holland, when reaching Nairobi, failed to come up to the original test in the country of origin, although there was some improvement after being kept at Nairobi for a few weeks. Check tests of seed flown back to Holland showed a similar loss of germination. No difference was found in samples of cotton fumigated with methyl bromide and the control when done at the Scott Laboratory, but similar treatment at the Coast resulted in a drop of about 40 per cent. Deterioration occurred in a sample of lucerne seed kept at the Coast for a short period. A sample of *Panax quinquefolium*, "Ginseng", from the U.S.A. has not so far been induced to germinate.

Eighty-nine plant specimens were added to the Herbarium and a number of plants identified. The help of the E.A. Herbarium staff in identifying unknown specimens is gratefully acknowledged.

Acknowledgments

Grateful acknowledgments are made to Dr. William Black for continued interest in the blight problem in Kenya and for maintaining a supply of blight-immune material for trial; to B. M. Wallace, Esq., of the Ministry of Agriculture for Northern Ireland, and John Clarke, Esq., for the supply of "Ulster" potatoes; to Dr. J. S. Niederhauser for the supply of blight-resistant varieties from Mexico; to Mrs. N. McDermott for the identification of varieties of potatoes from Kenya and for assistance in obtaining supplies of seed of commercial varieties; to Sir T. A. Wedderspoon for kindly supplying varieties from Scotland, and to the Netherlands Institute for Research on Field Crops for the supply of varieties of Dutch potatoes for trial.

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ANNUAL REPORT OF THE SENIOR SOIL CHEMIST, 1957

Fertilizer and Fertilizer Studies

(MR. E. BOSWINKLE)

The results of the 1956 fertilizer trials in African areas were analysed and a field programme of similar magnitude was undertaken in 1957. Design details in 1957 remained generally the same as those used in 1956 except that complete replicates rather than single blocks were put down on each site, the aim being to minimize confounding effects. In Central Province the soil/vegetation/climate pattern is relatively simple and so it has been possible to achieve an economical distribution of trials. In Southern Province rainfall exerts a dominant influence on crop response and consideration of this reliability again simplified site selection there. In Nyanza Province the soil pattern is complex and is of dominant importance in determining responses: accordingly, a high density of trials has proved necessary for reliable information to be obtained and progress has been correspondingly the slower. Progress in Nyanza Province was still further slowed through many of the areas in which trials were undertaken being single crop areas. In Rift Valley Province work was confined to a few scattered reconnaissance trials.

In Central Province, trials were undertaken in the Woodland zone on maize only and were too few in number for responses to be clear cut. In the Star grass and Kikuyu grass zones the main test crops were potatoes and maize. Responses due to double supers and to FYM were widespread, averaging 14.2 and 13.1 per cent for double supers on potatoes and maize and 23.8 and 23.4 per cent for FYM on these crops. Additionally, in areas where the land had been under prolonged cultivation, satisfactory responses of around 18 per cent were obtained to sulphate of ammonia application. The residual effects of double supers and FYM as measured by beans were less certain. In the Bracken zone, maize and oats failed on the most acid soils unless they had been limed while in the presence of lime double supers and FYM were again beneficial. There were no indications of interactions of important magnitude but more trials are necessary to confirm that manure and the effective fertilizers can be applied independently.

In Nyanza Province the main test crop was maize. Widespread responses to double supers of average magnitude around 16 per cent were obtained on the reddish-brown loams on the Kisii Highlands, and on the red granitic coarse sandy loams of Elgon and North Nyanza Districts. Responses to FYM were recorded on the shallow pallid sedimentary soils near Busia, on the red and orange granitic coarse sandy loams and erratically on the Kisii Highlands. Responses to sulphate of ammonia were restricted to the pallid sedimentary soils near Busia, where they attained a magnitude of around 28 per cent, the orange coarse sandy loams derived from Leuco granite near Chuele and in the lower Kisii country. Present indications are that the alluvial soils of the Kano Plains do not respond to fertilizers.

In Southern Province the crops under test were maize in the wetter and millet in the drier areas. Response to double supers were universal on the red, sandy loams at all altitudes except for an area north-west of Kangundo in which the general yield level of maize is very high. However, more trials are needed to secure adequate coverage of these soils. Very great responses amounting to around 40 per cent were recorded on millet on deep, red sandy loams on the Makueni Settlement and, in addition, there were strong residual effects. Responses south-east of Kangundo with maize and on the pink, coarse sandy loams of Makueni with millet were less. Erratic responses were obtained on the pallid,

coarse, loamy sands of Kiteta and Makueni but probably these soils are only slightly responsive. In the Kiteta-Masii areas and in parts of Makueni it is clear that soil moisture is the main determinant in crop growth and that fertilizer investigations need to go hand in hand with moisture conservation. The possibilities in this direction are now being investigated. Responses to farmyard manure were also fairly widespread though, in the drier areas, placement below the seed was observed to lead to impaired germination and establishment through a breaking of continuity in water surface. Responses to sulphate of ammonia were recorded on the pallid, coarse, loamy sands of Makueni.

Based on the 1956 results, initial recommendations have now been issued to field services staff regarding the use of fertilizers on African lands and these recommendations have become incorporated in Departmental policy for Kenya.

In Exploratory trials on sugar, marked benefits have been obtained at Chemilil from the application of 50 lb. per acre of nitrogen as sulphate of ammonia but not from similar applications of phosphate or potash. The benefits of nitrogen on sugar are now recognized in the locality and leading estates are fertilizing with urea as a regular plantation practice.

NPK rates trials were continued at Kitale, Kakamega, Sotik, Bomet, Miwani, Embu, Makaveti, Kampi-ya-Mawe and Shimba Hills, a phosphate residual in the 10th season after application being recorded at Kampi-ya-Mawe. A rates trial on rice on the Mwea Irrigation Scheme showed that, provided only limited amounts of top-soil are removed for Bund construction, striking increases in yield are obtainable from a 75 lb. per acre application of double supers while nitrogenous fertilizers have little benefit. Previous trials have demonstrated that where loss of top-soil is considerable, nitrogen fertilizing becomes important in the growing of rice.

Forms of Phosphate Trial

Further comparisons were undertaken in phosphate-responding areas and on phosphate-responding crops of the effectiveness of different phosphatic fertilizers likely to be of interest to the farming community. The techniques adopted followed those of 1955 and 1956. Trials were carried through to harvest and results are available for wheat on Kinangop grey silt loam and for a newly-established grass/clover ley on Kitale loam. The no phosphate/double supers data for the Kinangop trial fitted the Mitscherlich response curve $Y = 1,425 - 758 \times 10^{-0.03691x}$ where Y is the yield of grain in lb. per acre obtained from an application of X lb. P_2O_5 per acre as double supers. The curve constants indicated a higher yield potential in the 1957 trial (1,425 lb. per acre) than in 1955 (845 lb. per acre recorded in the 1956 Report) and a greater responsiveness to phosphate. Under the 1957 trial conditions, among the fertilizers tested, only single supers (with a percentage efficiency of "over 100" compared with 112 in 1955), showed up satisfactorily. Hyperphosphate (with a percentage of 2.9), basic slag (with a percentage efficiency of 18.1) and soda phosphate (with a percentage efficiency of 25.0) performed more poorly than in the previous trial. The effectiveness of the phosphate in Uganda rock phosphate amounted only to 1.9 per cent of that in double supers. It was computed that applications even of soda phosphate or basic slag would need to be ten times the rate for double supers for a comparable effect to be achieved.

In the Kitale trial the establishment and second cuts only showed a significant response to phosphate. The no phosphate double supers data for these two cuts did not fit a Mitscherlich response curve and so for computing efficiencies simple quadratic curves were used. The fitted equations were: For the establish-

ment cut, $Y = 0.19125 \times x^2 + 2.025 \times x + 659$ and for the second cut, $Y = 0.01525 \times x^2 + 4.65 \times x + 1,009$ where Y is the yield of dry matter in lb. per acre obtained from an application of x lb. P_2O_5 as double supers.

Uganda rock phosphate and again basic slag had little effect on establishment and hyper-phosphate (with a percentage efficiency of 24) and soda phosphate (with a percentage efficiency of 39), though more effective than in 1955, once more were distinctly less beneficial than the water-soluble phosphates. Best establishment was achieved with ammonium phosphate of which percentage efficiency was 126. The effectiveness of the non-water soluble phosphates improved after establishment and in the cases of hyperphosphate, basic slag and soda phosphate (with percentage efficiencies 62, 101 and 83 respectively) approach or equal that of double supers. Ammonium phosphate (with percentage efficiency of 202), however, remained the most effective. Only basic slag and double supers persisted at all beyond the second cut. As a mere five weeks elapsed between the second and third cuts compared with the four months which had passed between the time of phosphate application and the taking of the second cut, it seems likely that the decline in phosphate effectiveness reflects a change in plant requirement (possibly through seasonal causes or through greater root development and consequent utilization of other sources of phosphorus in the soil), rather than fixation of the added phosphate in the soil.

Phosphate addition led to a striking reduction in the crude protein content of the herbage in the establishment and second cuts, with some slight reduction persisting in the third cut. The depression of crude protein was greatest with the water-soluble phosphates. The crude protein content of the herbage in all treatments declined after the establishment cut and fell rapidly between the second and third cuts. The fertilizer treatments had a greater effect on dry matter yield than on crude protein content in the dry matter and so phosphate application led to increased crude protein production per acre despite the depression of content. This increased production was significant with the more effective fertilizers in the first two cuts.

The phosphate content of the herbage and the effect on it of phosphorus applications are similar to those recorded for leys by Dougall ("Fertilizer Experiments on Ley Establishment and on Permanent Grassland in the Kenya Highlands", presented to the East African Conference on Soil Fertility, 1953). The fertilizer effects being relatively small, phosphate production per acre followed dry matter production.

At the request of the Pasture Research team, the Kitale trial included a gypsum factor. The most complete data from the trial includes gypsum treatments and the phosphate data presented below, together with the percentage efficiency calculations, are all on the basis of gypsum-treated land. Gypsum, unlike the phosphate, had little effect during establishment but increased greatly in effectiveness between the second and third cuts. Its application then led to significant increases in dry matter, crude protein and phosphate production in spite of small depressing effects on crude protein content and distinct depressing effects on phosphorus content. The effect on crude protein content and the declining of crude protein content with advance in the season are disconcerting in view of the improved legume establishment at Kitale which has been observed so often as a result of gypsum application in association with phosphate. This is particularly so as the most likely explanation of the gypsum behaviour is that the legume component of the ley takes much longer than the grass to become established and so the gypsum operating as it does through the legume takes longer to express itself. Gypsum application tended, if anything, to diminish rather than to enhance phosphate effects.

The following table summarizes data on which this discussion is based:—

TREATMENT	P ₂ O ₅ lb. per acre	DRY MATTER YIELD LB/ACRE			% CRUDE PROTEIN			IN DRY MATTER % PHOSPHORUS		
		Est. cut	2nd cut	3rd cut	Est. cut	2nd cut	3rd cut	Est. cut	2nd cut	3rd cut
No phosphate	0	659	1,008	1,767	21.57	16.55	12.18	0.26	0.26	0.22
U.R.P.	132.7	639	1,059	1,813	20.03	16.65	12.57	0.28	0.27	0.21
Hyperphosphate	78.1	765	1,271	1,795	18.72	15.91	11.73	0.25	0.27	0.22
Soda phosphate	48.9	766	1,226	1,684	19.58	15.37	11.38	0.25	0.24	0.19
Basic slag	53.1	583	1,301	1,970	19.38	15.36	11.32	0.26	0.24	0.21
Double supers.	20	776	1,163	1,559	17.78	14.24	11.91	0.28	0.26	0.22
Double Supers	40	1,046	1,439	1,943	18.21	15.25	12.27	0.25	0.27	0.20
Ammonium phosphate	40	1,266	1,485	1,660	17.83	14.47	11.37	0.26	0.26	0.22
No gypsum	—	924	1,059	1,375	18.52	15.61	11.99	0.27	0.28	0.24
Gypsum applied	—	837	1,291	1,805	19.02	15.40	11.70	0.26	0.25	0.21

A number of farming trials with similar objects on maize and wheat were also undertaken in Rift Valley Province and the residual and cumulative studies with Uganda rock phosphate, double supers and soda phosphate at Eldoret were continued. The Eldoret trials are being used to provide material for phosphate fixation studies at E.A.A.F.R.O.

Trials are also in hand in phosphate-responding areas to determine the most efficient crop sequences and points in the crop sequence on which to apply phosphatic fertilizers. Quite apart from fertilizer effects, interesting crop sequence effects are being observed in these trials.

Nitrogen application technique studies have covered a continuation of the 1956 forms of nitrogen studies and investigations of times of application. In these, the earlier Embu observation that for cereals a split dressing, part at planting and part well into the rains, is effective when a similar dressing given at planting is ineffective, has been repeated in Coast Province.

Lime Fertilizer Studies

(DR. L. A. WHELAN)

Work on the four field experiments laid down in 1953 and 1954 was continued with reapplication of fertilizer treatments.

At Kaptagat the growth trends anticipated in the 1956 crop went through to harvest and significant yield depressions of 318-761 lb./acre from a no lime yield of 871 lb. were recorded when calcitic limestone or the heavier dressings of magnesian limestone were given. Phosphates gave highly significant increases of 243-341 lb./acre over a no phosphate yield of 361 lb/acre, the increases being greater with the heavy rates of application than with the low. Again, in reversal of the 1955 results there was such a large negative lime-phosphate interaction that except at the lowest levels of magnesian limestone, phosphates were virtually or completely ineffective in the presence of the amendment. The large 1955 nitrogen effect was not repeated.

The possibility that the 1956 inversion at Kaptagat is due to nutrient deficiency induced by the successful and responsive crop taken in 1955 was examined by pot and microbiological test; the results were inconclusive, the only indication obtained being the expected increased uptake of molybdenum by plants grown on the limed soil. Following on a suggestion by Bremner (*Nature*, 158 (1947), 798) that bivalent metals can be held in the soil as organo-metallic

complexes. the possibility was tested that the yield inversion is associated with a destruction of these complexes and a consequent loss of capacity for the soil to retain the heavy metal trace elements in an available form. Moodies' Activity Index (Soil Science 70, (1950) 461-477) was taken as a measure of the organo-metallic complexing ability of soil organic matter, and this was found to correlate with that part of the copper in a copper-saturated soil held in a non-exchangeable form. In these studies, added copper was found preferentially to be taken up by soil organic matter rather than by the mineral fraction. Liming was found actually to increase the capacity of soil organic matter to retain copper and theoretical mechanisms, based on the hydrolytic decomposition of the organo-metallic complexing agencies, were developed to explain the observed effects.

Early growth in 1957 was satisfactory and was in keeping with normal responses rather than with the abnormalities of 1956, but severe buck damage later in the season made the crop not worth harvesting.

Other laboratory investigations concerned the major nutrients on surface (0.8 in.) and subsoil (8-16 in.) samples collected early in 1957. Few pH changes were recorded though, even after four years, the full effect of the heaviest lime dressing had yet to be felt. About half the added limestone at all rates of application had been taken up by the exchange complex but none had penetrated to the subsoil.

On account of the thinness of the soil at Eldoret, the crop virtually failed in the absence of phosphate and potash and again was poor even where abundant phosphate was given. Phosphate application smothered the potash effect and this disappeared even when the lowest phosphate dressing was applied. No level or form of limestone was significantly effective. Surface soil pH showed little change since the last sampling. The effect of lime application is now detectable in the subsoil and here the pH values where lime had been applied, are distinctly higher than below the unlimed plots. Some calcium was taken up by the exchange complex between the 1956 and 1957 samples and over half of the calcium in the added limestone is now present in exchange combination with the soil.

At Marindas the long period the land has been under wheat has led to severe weed infestation and increasing difficulty in securing satisfactory crops so the trial in 1957 was sown to perennial ryegrass and Louisiana white clover, super phosphate alone being applied. A good grass establishment was obtained in the face of the weed competition but there was little sign of clover. No yield cuts were taken during the year. Surface soil pH on the limed plots dropped slightly since the previous sampling and there were inconsistent changes in the subsoil also. The great part of the calcium in the added limestone had been taken up by the soil and was detectable in the exchange complex.

At Kinangop wheat was grown in the 1956/57 season but there was a considerable growth of volunteer barley from the previous season, especially on the limed plots. Phosphate application led to significant yield increases of 223-250 lb./acre over a no phosphate yield of 709 lb., and liming led to increases of 107-199 lb./acre over no lime yields of 837 lb., the larger differences being associated with the heavier dressings and being highly significant. Following the large nitrogen effect observed at Kaptagat in 1955, the Kinangop plots were split, on one half of each plot the straw from the preceding barley crop being ploughed in, while on the other half it was carted away before ploughing. The mean resultant yield difference between the straw disposal treatments was small and there were no consistent interactions with the full plot treatments. Consequently,

no evidence was obtained that the 1955 nitrogen effect at Kaptagat was connected with straw decomposition. The surface soil pH fell distinctly from the levels at the previous sampling, particularly where calcitic limestone was applied. Limestone application also had an appreciable effect on the subsoil and had raised the pH and base saturation there quite as much as in the topsoil.

			pH				BASE SATURATION %			
Treatment	..	..	L ₀	L ₁	L ₂	M	L ₀	L ₁	L ₂	M
Topsoil	..	..	5.02	5.64	5.93	5.61	42	54	60	55
Subsoil	..	..	5.00	5.37	6.04	5.72	49	56	60	61

The penetration of the lime effect to the subsoil here is accounted for by the deep ploughing which is the normal practice of the farmer on whose land this trial is undertaken.

At all centres, exchange magnesium increased with increasing application of magnesium limestone and either suffered no significant change or was depressed where calcitic limestone was applied. Annual sulphate of ammonia application led to an important decrease of pH only at Kinangop (with a mean depression of 0.4 units). Elsewhere, its effect on pH has been negligible. Mehlich barium chloride/triethanolamine extractable aluminium was low especially at Eldoret and Kinangop and was not consistently affected by liming.

Soil Analysis and Characterization

(DR. A MEHLICH)

1957 was made notable by the arrival in July of Dr. A. Mehlich to work for two years in Kenya under an ICA International Co-operation Administration project. After an initial appraisal of the nature of our fertility problems and the contribution he could best make towards their solution, he went ahead with testing the applicability in Kenya of the rapid routine analytical procedures which he has developed for the assessment of nutrient status in the red and yellow soils of the south-eastern United States. He also sought to apply methods which he has developed for the chemical characterization of the clay minerals in soil. The procedures involved are elaborations and modifications of those described in *Soil Sci. Soc. Amer. Proc.* 2 (1938), 279-288; *Jour. Assoc. Official Agric. Chem.* 36 (1953), 445-457; *North Carolina Dept. of Agric., Mimeographed Publication S.T.D.P.*, No. 1-55 (1955), and *Jour. Assoc. Official Agric. Chem.* 39 (1956), 518-523.

The soils on which he worked covered a cross-section of the diversity of conditions under which farming is attempted in Kenya: of soil textures, parent materials, colloidal characteristics, climate, vegetation zones, farming systems, cropping and erosion history. The scatter of data which he has obtained from this varied material has proved satisfactorily wide. Where appropriate, these data have been compared with the fertility data using conventional extraction procedures during the normal routine soil analysis activities of the Chemistry Section. The comparisons have been sufficiently satisfactory to justify his starting building a laboratory organization around these rapid procedures for the future undertaking of routine soil analyses. Meanwhile, the opportunity of testing the applicability to field conditions of rapid soil fertility assessment procedures is presented under an ICA soil survey project which comes into operation in 1958, and this is being taken.

Our deep red loams and bracken zones have been recognized in the Mehlich scheme as Kaolinite/Halloysite mixtures frequently in association with free sequioxides and our more dark-coloured soils as Illite/Vermiculite mixtures frequently in association with Montmorillonite. Methods are under development for the semi-quantitative representation of the contents of these constituents in our soils. Such clay characterization data is anticipated to provide a basis for the rational interpretation of laboratory-determined soil fertility data which is now lacking.

Bioassays

(MR. A. PINKERTON)

The 1956 investigations of soil nutrient deficiencies by pot culture following the Webb technique were continued, 17 soils in all being examined during the year. Following 1956 practice, all soils with a pH below 5.6 were limed to approximately half their theoretical lime requirement, magnesium hydroxide being used in place of calcium hydroxide in the "minus calcium" treatment. The extra-curricula "lime" treatment on the less acid soils was replaced by a treatment in which the major but not the trace elements were given.

The most widespread and serious deficiency again was phosphorus. This attained significant magnitude in 13 of the 17 soils and in the majority of cases growth in the absence of phosphate approximated to that in the absence of all nutrients. The phosphorus indications of the pot tests correlated with N/21 sulphuric acid extractable soil phosphorus (Beater: Plant and Soil 1 (1949), 215-220).

Nitrogen deficiencies were marked in soils from Coast Province and from the Mwea and Perkerra irrigation schemes and were apparent in soils from some citrus orchards near Machakos. The indications were in close accord with micro-Kjeldahl laboratory determinations.

Two instances of potassium deficiency were recorded, both from the eastern fringes of the Uasin-Gishu Plateau. In neither cases had chemical determination indicated the existence of these deficiencies: indeed, the exchangeable potash status of these two soils were up to ten times as great as those recorded for soils on which no potassium indications were obtained.

Calcium deficiency was widespread and in one case—from a site in the Bracken zone of Central Province where growth in an NPK lime exploratory trial was virtually non-existent in the absence of lime, the plants which had not been supplied with calcium all died early in growth. All the four soils examined from Coast Province made only half the growth in the absence of calcium compared with that made when calcium was applied. Responses were also obtained on the two Uasin-Gishu Plateau fringe soils, on soils from Njoro and from the Mwea irrigation scheme. Correlation between pot test indications and laboratory determined neutral normal ammonium acetate soluble calcium was good.

Manganese deficiency indications were obtained at Msabaha, on lagoonal sands in the coastal strip, at Njoro, Kipkabus and, surprisingly, in the Bracken zone. No correlation appears to exist between the pot test indications and either exchangeable or easily reducible (Sherman *et al.*: *Soil Science*, 54 (1942), 253-257) manganese.

Copper deficiencies were widespread and were recorded from Coast Province to the Uganda border including many sites in Rift Valley Province. Zinc deficiency was also widespread, usually occurring in association with copper deficiency.

Molybdenum deficiencies were recorded from Coast Province, from the Bracken zone and from some sites in Rift Valley.

Sulphur deficiency was marked and was reflected in growth depression on the Mwea irrigation scheme sample and, to a less extent, on the Uasin Gishu Plateau fringe samples. In other cases, while growth was satisfactory, the characteristic chlorotic leaf-spotting associated with sulphur deficiency was observed where sulphur was withheld. Extension of the growing period of the test is now being tried with a view to this chlorosis finding expression in terms of yield. Few instances of magnesium deficiency have yet been found and only on soil from part of the Bracken zone has the deficiency been appreciable. Instances of boron deficiency have been equally rare.

The estimation of available molybdenum on 11 soils and zinc on eight soils following Nicholas and Fielding (*J. hort. Sci.* 26 (1951), 125-148) were also undertaken. The molybdenum estimation technique was found unsatisfactory under local conditions while the zinc figures, though reproducible, did not correlate with the pot test indications.

A geo-chemical basis of classification of the pot test indications is being sought, though as yet too few samples have been examined for any generalizations to be distinguishable. Nevertheless, indications are encouraging, for the four contrasting soils so far examined from the sediments of the coastal strip are all deficient in nitrogen and calcium and tend to be deficient in manganese. Also where profound weathering to Mehlich determined (*Jour. Assoc. Official Agric. Chem.*, 36 (1953), 445-457) Kaolinite/Halloysite/Sequioxide mixtures has occurred, copper deficiency indications are general and zinc deficiencies frequent.

The pot tests are now being followed in all areas by field trials aiming to confirm their findings and to provide information on application rates and techniques.

Soil Surveys and Irrigation

Soil survey activities in the main were confined to the analysis of the accumulated material from experimental stations and from major irrigation projects now under development or examination by the Kenya Government. These included a new project near Lodwar, based on the utilization of flood spates in the Turkwell river for the irrigation of some 3,000 acres of recent alluvium. The field work on this project was undertaken for the Kenya Government by private consultants.

The salinity investigations undertaken at Hola are discussed in the section of this volume which deals with irrigation investigations.

Nitrogen in Rainfall

Determination of the ammonia nitrogen content of rain-water collected at Scott Agricultural Laboratories was continued for the eighth successive year. The results from daily collections in 1957 were:—

Month	..	..	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall			9.04	1.48	1.23	8.82	13.24	1.84	0.34	0.34	1.20	2.35	6.33	2.31
Rainy days			12	5	11	16	20	5	5	6	3	6	19	8
Ammoniacal N added by rain lb./acre ..			·077	·048	·154	·502	·630	·148	·007	·128	·256	·785	·760	·122
Lb./acre per inch of rainfall			·008	·033	·125	·057	·048	·080	·021	·377	·021	·334	·120	·053
Lb./acre per inch of rainfall (mean over 8 years)			·091	·114	·106	·072	·074	·043	·086	·129	·093	·154	·096	·072

Total rainfall 48.67 inches.

Total addition of Ammoniacal N:

Lb./acre 3.617

Lb./acre per inch of rainfall ·074

Lb./acre (mean over 8 years) ·081

The smallness of the addition of ammoniacal nitrogen in rainfall and its variability is again noteworthy.

Wheat Quality

(WHEAT QUALITY COMMITTEE AND MR. H. C. HODGSON)

The programme of field trials aimed at investigating the factors determining wheat quality and seeking its improvement in Kenya was continued. Special attention was paid to rust control with the result that there was a striking improvement in the 1957 trials over those in preceding years. The long-term quality trials, in which the accumulative effect of environment on wheat quality is determined, were continued at four representative localities in the wheat-growing areas of the Kenya Highlands. Additionally, a fifth trial was started in an area where a hot, dry ripening season, in contrast to the more humid conditions of our wheat areas, is normally expected. The accumulative effect of grain selection on the basis of plumpness (which is widely practiced among Kenya farmers in the choosing of their seed) on dough strength was also brought under investigation. The 1956 nitrogen and phosphate application trials produced no significant results at the fertilizer application rates then used. Similar trials were undertaken in 1957 at the four wheat stations with the maximum nitrogen application rate raised to 4 cwt./acre of sulphate of ammonia and with a variety comparison included. 1957 results are not yet complete but initial indications are that nitrogen fertilizing at the high rates used does bring with it an increase in crude protein content in the grain but this is not necessarily associated with an increase in dough strength. Australian and Canadian observations on the greater residual benefits of legume leys than of nitrogen fertilizing on wheat quality have attracted attention in this connexion and now that actively nodulating legumes are becoming available in the Kenya Highlands, investigations are being extended to cover possibilities in this direction.

Associated with the field experiments, wheat gluteins are being isolated from selected grain samples of contrasting protein content and dough strength and from a number of local and imported varieties. Apparatus has been assembled for the electrophoretic separation of these gluteins into their constituent proteins (with a view to the identification of these proteins) and, if required, for their hydrolysis into their constituent amino acids for chromatographic separation. While the investigations aim to relate dough strength with protein make-up, already they have given indications that, in Kenya wheat, strength is related partly to gluten (as distinct from crude protein) content and partly to the physical characteristics of the gluten itself.

Moisture Determination in Maize

(R. J. KEMPTON AND A. PINKERTON)

At the request of the Maize Controller, investigations in continuation of those reported in 1953 were undertaken into the use of the Marconi moisture meter for the rapid estimation of moisture in maize. The request stemmed from uncertainties which appear to be inherent in the use of oven-drying procedures at atmospheric pressure at high altitudes as calibration standards for moisture determination in grain. It arose also from the difficulty which exists in distinguishing loss of weight through loss of moisture from loss of weight through chemical disintegration at the relatively high temperatures used in the determination of moisture content at atmospheric pressure. Changes in moisture content during grinding are also involved. The need for a reliable standard procedure which is reproducible in all places and at all altitudes where grain is bought was recognized and was the subject of one of the resolutions of the First C.S.A., Conference of Specialists on stored food products, held at Salisbury, Southern Rhodesia, in January, 1957.

The 1957 investigations started with an investigation of the behaviour of maize grain conditioned to different moisture levels before grinding, when dried under high vacuum and at temperatures at which little thermal decomposition of the grain constituent takes place. Vacuum oven drying for 30 days under these conditions was found necessary for the changes in recorded moisture content to indicate that equilibrium had been attained. Even then a fluctuation of at least 0.1 per cent was found to occur between different readings on the same sample. Parallel moisture determinations were made on the maize meals concerned by oven drying at 130° C. for one hour and, each in triplicate, with four different Marconi moisture meters. The following table sets out the mean results obtained: —

MOISTURE ESTIMATION PROCEDURE			
SAMPLE NO.	Vacuum oven drying	Oven drying at 130° C	Marconi Meters (SA scale) average of four meters
1	4.54	4.33	—
2	9.81	9.54	9.29
3	10.78	10.32	9.73
4	12.49	12.15	11.31
5	13.78*	13.65	13.23
6	—	15.36	15.41
7	17.13	16.69	17.18

*After 19 days drying.

The four meters varied slightly in reproducibility, and one meter read consistently higher and one consistently lower than the others. However, at worst, single determinations came within 0.35 per cent of their triplicate mean and the triplicate means for the meters at worst differed from one another by no more than 0.3 per cent. These differences were as small as the differences between duplicate samples in both oven-drying techniques and this suggests that they are due to sampling rather than inherent determination procedure factors. The Marconi moisture meters behaved best where the moisture content was between 10 and 14 per cent. In this range, under local conditions, a further study showed that exposure of maize flour to the atmosphere after grinding had the least effect on moisture content and it is over this range that reproducibility in moisture determination is of greatest importance to Maize Control. The South African scale for the Marconi moisture meter gave rather lower moisture values than either of the oven-drying procedures, but in the critical 13 to 14 per cent region the difference is not material so far as maize buying is concerned. The difference between the moisture content as determined by oven-drying at 130° C. for one hour and by vacuum oven-drying seldom exceeded the likely difference between replicate mean by either procedure. This suggests that even at our high altitudes there is no material advantage to be obtained from using a high vacuum oven-drying technique as the moisture determination standard in preference to a determination at atmospheric pressure.

Bush and Weed Control

The herbicide conference organized at Magugu in January, 1957, and reported in *E.A.A.J.* 23, (1957) 1-38, attracted much attention and was well attended by Kenya delegates. Interest in and the use of weed killers were well sustained by the larger scale farmers and good progress was made by spray contractors in the use of aerial spraying for weed control particularly in wheat,

over 25,000 acres being sprayed in this manner during the year. The Department as well as the trade continued trials with weed-killers, special attention being directed departmentally to the use of weed-killers in maize, the control of couch (*Digitaria scalarum*), in arable and plantation crops, to the efficacy of new products as they become available for the control of resistant weeds such as cleavers, spurry and bindweed in cereals, and to bush control in extensive grazing. Weed-killers to which pyrethrum is not sensitive continued to be sought. Some progress continues to be made in these trials but with the narrowing range of bush and weed species for which satisfactory controls are lacking it seems that the possibilities for control become correspondingly less. Consequently, until some entirely new herbicidal approach develops, the possibility of progress on a scale matching the introduction of the phenoxy-acetic acid derivatives seems unlikely.

The need for prickly pear control in Naivasha and Nanyuki districts during the year became a matter for increasing local concern. An even greater problem exists in the control of this pest in parts of the coastal hinterland, for here recognized eradication procedures are vastly more difficult to apply.

Publications

H. C. Hodgson (1957).—Paper Chromatography of the False Pyrethrins. *J. Sci. Food Agric.*, 8, 347-350.

Acknowledgment

Special acknowledgment is due to the United States Government for its generosity in making available to Kenya under an ICA plan the services of Dr. A. Mehlich of the North Carolina State College, and for their provision of financial assistance for the project on which he is working. Already we have found his sojourn with us to be highly stimulating and we look forward to another 1½ years of fruitful association with him.

E. BELLIS.
Senior Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1957

I—Review of the Year

The season was marked by excessive rain in May, followed by a long, dry period: in particular the July-August rains were a virtual failure. Rain late in the year benefited crops in the high country but the drought conditions led to poor wheat yields in the Trans Nzoia. Nevertheless, in general, the year has been a good one for cereals and losses from disease were lower than for some seasons past. The actual rainfall for Njoro is quoted in Table 1.

TABLE 1—NJORO RAINFALL, 1957

MONTH	1957	28 year average	MONTH	1957	28 year average
January	1.49	0.97	July	1.48	4.32
February	0.25	1.25	August	2.49	5.07
March	2.41	2.61	September ..	0.47	2.65
April	2.41	5.46	October	1.30	1.98
May	9.26	4.36	November ..	4.84	2.61
June	3.07	3.38	December ..	2.33	1.82
			TOTALS ..	31.80	36.48

Seven new wheat varieties and a barley were released at the end of the year and should provide a welcome addition to the range of varieties, particularly in the lower areas. There has, however, been some difficulty in the implementation of the Pedigree Scheme because of mixing of seed on farms in the final stage of multiplication. Supervision of the important field operations is now to be arranged in order to improve the standard of workmanship.

Important developments have been undertaken this year, of which the most noteworthy were the purchase of 200 acres of new land adjoining the Plant Breeding Station for seed production, the start of building of the Laboratories, and extra housing for further senior staff. Such developments mean that much progress is being made towards providing the necessary facilities for the continued expansion of the programmes of work. Further appointments of graduate staff are still expected. A most encouraging sign is the great interest the wheat industry itself is taking and the financial help which the producers are arranging to contribute.

By courtesy of the Rockefeller Foundation the writer spent sabbatical leave with the wheat programme in Mexico and South America to study the work which has been built up so successfully there. In addition, other members of the staff were able to visit Rhodesia and Tanganyika in connexion with maize and sorghum breeding. Such visits are of great benefit and should be encouraged.

With the plant breeders at Kitale and Machakos firmly established and the main station at Njoro undergoing great development, the section is now more broadly based than formerly and able to make a far better contribution to the agriculture of the country.

II—Survey of Field Crops

Wheat has fallen by some 90,000 acres (26 per cent) over the two-year period 1955/57; the maize acreage has remained relatively constant, and barley and oats have shown increases of 160 per cent and 60 per cent respectively. The relevant information is given in Table II.

TABLE II—CEREAL ACREAGES, 1953-1957

YEAR	WHEAT		MAIZE		BARLEY		OATS	
	Acres '000	Bags Acre	Acres '000	Bags Acre	Acres '000	Bags Acre	Acres '000	Bags Acre
1953..	289	4.60	165	6.69	31	5.86	23	6.33
1954..	291	5.10	174	9.11	29	7.30	22	7.02
1955..	345	3.93	158	7.89	24	6.62	19	6.72
1956..	316	4.43	166	7.67	42	7.29	25	7.85
1957..	256	4.86	167	8.04	63	7.60	31	8.43

VARIETIES

The main wheat varieties grown during the season and their acreage percentage for the three-year period 1955/57 are shown in Table III. As is customary, advice on the choice of varieties was given to the farmers in the broadsheet "Cereals for 1957/58" by H. C. Thorpe, which appeared in the local press and the *K.I.O. Fortnightly*, No. 426 of 21st January, 1957.

TABLE III—WHEAT VARIETY ACREAGES, 1955-1957

VARIETY					1955	1956	1957
					<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Sabanero	..	..	..	..	17.9	21.7	25.4
Equator/Baby Equator	..	..	..	..	3.9	11.5	12.7
131	..	..	..	..	12.8	11.0	10.1
1066	..	..	..	..	9.4	7.6	9.6
362	..	..	..	..	—	1.3	7.4
Ceres	..	..	..	..	5.2	8.1	5.5
354	..	..	..	..	—	6.5	4.0
294	..	..	..	..	7.7	6.2	3.9
Hopeful	..	..	..	..	—	—	3.4
358	..	..	..	..	—	0.8	3.0
Regent	..	..	..	..	1.4	4.9	2.8
Impala	..	..	..	..	—	—	1.8
Sterling	..	..	..	..	—	—	1.6
363	..	..	..	..	—	—	1.1
Others	..	..	..	..	41.7	20.4	7.7

The main pattern of varietal distribution remained the same as in 1956, with the soft red group (Sabanero, Equator, 131 and 1066) heading the list in the same order as in the previous season. This group, as a whole, has increased in the period 1951-1957 from 29 per cent to 58 per cent of the total acreage and is causing serious difficulty to the milling and baking trade on account of its poor baking quality. The new release 362 increased from 1.3 per cent to 7.4 per cent whilst most of the older varieties virtually disappeared from cultivation due to stem rust susceptibility.

Regarding barley, the emphasis is now moving from the variety Research to the newer high-yielding Scandinavian types. Prior is no longer acceptable to the maltsters on account of its bad characteristic of delayed germination. The British variety Proctor has attained wide popularity in the country and is now accepted as suitable for malting: It is also hoped that No. 5 from Eire, released last year, will be accepted similarly. The problems with barley are far less than with wheat and it has been found that introduced varieties, particularly those from Europe, grow and yield well.

Oats in Kenya continue to be very susceptible to rusts and this limits their production. The standard feed oat still remains the Australian variety Lampton and Grey Algerian the standard porridge variety. The Canadian variety RL 1734 has continued to do well as a feed and fodder type and has satisfactory rust resistance. A further Canadian oat 3003 F, released last season, has rather more susceptibility to rust but has shown special value on ill-drained *vlei* soils in the higher altitudes.

The first Njoro Synthetic maize released for 1957 did well during the season, and encouraging reports have been received from individual farmers. It appears to have acclimatized itself to local conditions and this rather drier year has probably specially suited it. The first Kitale Synthetic is being released for 1958 planting.

DISEASES

Owing to the dry conditions, diseases of wheat have not been serious and stem rust and ear rust (*Puccinia graminis* and *Puccinia glumarum*) have been relatively unimportant. This is in contrast to 1956 when stem rust in particular caused serious damage to the crop. Crops of 354 and 294.M, planted against advice, were severely attacked and in some cases destroyed. A survey carried out during the year showed that K16 was the main rust present, as in 1956. In addition, three new races were suspected during the year, bringing the total now identified in East Africa to 19 races; of these, seven races have arisen during the last five years. Brown leaf rust (*Puccinia triticea*) has been more virulent in attack than for some years past and caused severe damage on certain varieties, notably Sabanero and Mida-Cadet in the Uasin Gishu and RL 2150/A at Endebess.

An encouraging feature has been the reduction in root diseases, particularly Take-All. Whilst the favourable season may to some extent have been responsible, the real reason is the reduction of the wheat acreage and the subsequent rotation of old Take-All lands to other crops. In one progressive district "guarantees" have been refused for more than two wheat crops in succession, and many farmers have themselves now shortened their wheat rotation.

III—Breeding—Wheat, Barley and Oats

The programme of wheat breeding at Njoro has continued to expand and at the same time there has been an intensification of testing at subsidiary sites. In particular this has been extended to Endebess and Naro Moru where stem rust is specially virulent and provides as severe a test as can be arranged. In order to publicize the lines of work upon which the programme is proceeding, a review article was published under the title "Review of Rusts to Attack Wheat" by H. C. Thorpe and G. E. Dixon in *The East African Farmer and Planter*, Vol. 1, No. 4 of January, 1957.

NEW ACCESSIONS AND CROSSES

The most important source of new material is the nurseries, discussed in the next section, but in addition, 65 new accessions were received as the result of specific enquiries. Special interest attaches to three of these which involve other *Triticum* species and related genera in their parentage. This approach for new sources of rust resistance is receiving attention particularly in North America and it is hoped that Kenya can benefit from the products of such research. The rust resistance of these first arrivals proved effective and is hopeful for the future.

With the re-establishment of the rust-testing work during the year, it was possible for 125 varieties of potential value as parents to be tested for resistance to current rust races; the range of resistance of most of them was better than expected. Chosen varieties from this series will now serve to extend the range of parents at present in use. The existing programme of crossings already uses a wide range of imported wheats and it is intended that this should now be expanded on the widest possible genetic basis. The need for this was demonstrated again in 1957 by the high proportion of selections from earlier crosses which were either destroyed or had to be discarded because of stem rust attack. Constant changes in the races of rust during the last few seasons has brought about a remarkably high degree of wastage in this respect.

The Kenya varieties now being used in the crossing work are 261.R, 184.P, 360.H, 294.M, 354.P, 356.A, 358.AA and Equator; in addition, Canadian Regent and Ceres R64, which are grown locally, are being used to build up varieties with better baking quality. A total of 117 crosses were made in 1957 and 182 Kenya crosses are under various stages of selection. A collection of 213 segregating progenies from Colombia was studied but stem rust destroyed a large proportion and results have been less encouraging than expected. There was also heavy rust infection in the Mexican nursery; this comprised lines with dwarf Japanese wheats (Norines) in the parentage and also some selections from the Canadian work in Mexico. However, material of value has been selected from these collections and more awaits sowing in the 1958 season.

During this period, work on barley and oats has perforce been kept to small proportions. The seven barley crosses made in 1953 have now almost reached readiness for first field plots and looked very attractive this year. A number of new barleys and oats were received, but the main interest in new oats was concentrated upon the International Nursery mentioned in the following section.

NURSERIES

Once again the International and Near East Wheat and Barley nurseries were grown; in addition, the International Oat Nursery was sown for the first time and yielded a number of varieties with hopeful degrees of stem and crown rust resistance. A special feature this year was the replication of the wheat nurseries at Endebess in a differing "rust climate" from the main site at Njoro. Appropriate reports were sent to the organizing authorities and once again much material has been obtained from these sources for use in Kenya. The value attached to these nurseries is therefore stressed; this co-operative effort on an international scale has made a very great contribution to wheat-breeding efforts throughout the world. The benefit to Kenya in particular is extremely important.

TRIALS

The wheat varieties in trial in the medium and lower areas were mainly those extracted from Nurseries in earlier years and likely to be of value for direct use. At Njoro the varieties Frontana-Kenya 58×Newthatch (II-50-25) and Mentana²×C9906 yielded best; these are specially noteworthy as being the only two of the ten varieties in foundation plots which survived the heavy rust attack. Rio Negro and Mida-McMurachy-Exchange (II-47-26) also yielded well, the latter showing excellent rust resistance but the former showing a fairly strong infection. At Eldoret, where a broadly similar set of varieties was in trial, these same four did well in spite of drought conditions.

At the high altitude sites (Molo, Ol Joro Orok and Kinangop) the trials were devoted to testing the derivatives of crosses 384 and 385, namely 318 × Equator. Good yields were obtained, generally confirming the choice of the eight

varieties being multiplied which are discussed in the next section. One disturbing feature has been the rather heavy incidence of stem rust in the Ol Joro Orok and Kinangop trials; the multiplication plots at Mau Narok on the other hand had almost none. It seems that this set of varieties may be of rather limited application, being safe at only the highest altitudes.

In barley trials, the best at Njoro were the new "Mid-season" selection of Research, and the varieties Donaria, Lichti, No. 5 and Maythorpe. On the other hand, Ingrid and Provost and, to some extent, Proctor, were disappointing. The Eldoret trial was too droughted to be of value. In the higher country, Mansholts 2-row, and No. 5 have done well in all three trials; Proctor on the other hand seemed more variable from site to site. Amongst newer barley varieties in observation plots prior to trial, Drost, Bethge, Heines Haisa, Isaria, and Domen have shown encouraging results.

No new oats were in trial during the year. The newly released variety RL 1734 continued to yield well; Fultex, on the other hand, proved more rust susceptible than had been thought and its further multiplication has now been abandoned.

MULTIPLICATIONS

As already noted, only two of the ten varieties under multiplication for foundation seed at Njoro survived the rust epidemic; these are Frontana-Kenya 58 $\times$ Newthatch (II-50-25) and Mentana² $\times$ C9906, both of which contain Kenya blood. There were 90 accessions mainly from the nurseries, and 252 field plots from crosses, which had not yet reached this stage. Many of the former did extremely well and their multiplication will proceed as quickly as possible. This contrasts with the heavy losses from rust in the Kenya crosses, where only 88 (30 per cent) of the new selections proved sufficiently satisfactory to merit harvesting.

In the high altitude wheat programme, the eight most promising selections from the crosses 384 and 385 already mentioned were multiplied as mother crops at Mau Narok. They grew outstandingly well, though a very wet harvest damaged some of them. Yield trial results confirm that the decision to proceed with these varieties was sound and has saved valuable time. The most outstanding were 385.Q.3.C.1, 385.N.3.A.3 and 384.BU.22.M.1; however, the strong development of stem rust at Ol Joro Orok and Kinangop suggests the need for caution and may restrict their use to only the highest altitudes.

Apart from the 384/5 group mentioned above, there were fewer mother crops in 1957 than previously and only two have done well enough to proceed to pedigree stage, namely Rio Negro and Spica (from America and Australia respectively). The wheats 78.M. Florence Aurore 8.193 and Qued Zenati had to be abandoned due to increased stem rust susceptibility. Fultex oats suffered similarly.

RELEASE OF NEW VARIETIES

Seven wheats and one barley have been released for 1958, as shown in Table IV. Details have been published in the local press and will shortly be the subject of a notice in the *East African Agricultural Journal*. The releases for 1957 were described in "Release of New Cereals—1957" by H. C. Thorpe and G. E. Dixon in *The East African Agricultural Journal*, Vol. XXII, No. 4 of April, 1957.

TABLE IV—VARIETIES RELEASED FOR 1958

VARIETY	Parentage	Altitude Range '000 (ft.)	Notes
RL 2150/A ..	<i>Marquis</i> ² x <i>Agropyron elongatum</i> .	6.5–7.5	Selections from Canadian variety.
362.B.1.A.2* ..	Equator x 294.M	7.5–9.0	Further to earlier releases.
367.AR.3.B.2.B*	Warigo x 184.P	6.0–7.0	From Wisconsin, U.S.A. Reselected version.
367.BR.1.D.4.B ..	Warigo x 184.P	6.0–6.5	
H.462.A–3–4.2.3 ..	Frontana x Thatcher–W38–Hope.	6.0–7.0	
Sabanero/1* ..	Rhodesian Sabanero ..	6.0–8.5	
339	192.Q.2.A.(L) x Australian 37/2.5.4.	6.0–6.5	From New Zealand.
Research (M–S)*	Research Barley	7.0–9.0	

*Available as Pedigree Seed (field approved).

IV—Breeding—Maize and Sorghum

To the programmes at Njoro, Kitale and the Coast, is now added work on maizes and sorghums for the short-season conditions of the Southern Province. In order to continue the publicity for current work in maize, the following review articles were published during the year:—

(1) “Maize Hybrids are more difficult to breed than Synthetics”—*East African Farmer and Planter*, Vol. I, No. 8 of May, 1957.

(2) “Reliable Maize Hybrids take at least 15 years to breed” by M. N. Harrison—*East African Farmer and Planter*, Vol. I, No. 12 of September, 1957.

NJORO—MAIZE

The Njoro work concentrated upon the preparation of Synthetic II and upon the top-crossing of all the older material ready for yield evaluation. It will be recalled that a trial of S_1 top-crosses was carried out in 1956; from this the best 24 were given a further trial in 1957. Both trials were significant and consistent, and have now enabled the 10 best S_1 lines to be chosen for the compounding of Synthetic II. The full 24 lines were sib-multiplied during the season in order to build up the seed supply in readiness. These top-cross trials, together with a further special trial, also served to confirm the superiority of Synthetic I over the station selected maize; in fact, the station has now turned over to using this synthetic for general farm use.

Synthetic I is now being used as the source of further lines which will be top-crossed to Synthetic II as the next step in the cycle of improvement. In the meantime, the full range of older material, much of it dating from before the war, has been top-crossed to Synthetic I for field evaluation in 1958. It is not considered that lines from this material will be suitable for inclusion in synthetic work, but may offer value for issue as top-crosses.

KITALE—MAIZE

The rapid expansion of maize-breeding at Kitale has continued, with the development of old material and the starting of new lines on an increased scale. Unfortunately, hail in June and a drought in August damaged the work to some extent but, in general, good progress was achieved.

A total of 135 early- and medium-generation inbreds were in trial giving a mean yield of some 22 bags (of 200 lb.) per acre as against 20 bags for the station maize. Full statistical analysis has yet to be completed, but it appears that five lines have given an increase over station maize of 30-40 per cent, 15 of 20-30 per cent and 44 of 10-20 per cent. This gives considerable encouragement for the future of a Kitale Synthetic II and for the use of the best lines individually for the development of hybrids. A further programme of top-crossing was badly damaged by hail but the majority of lines set enough seed for trial in 1958. Selfing work was concentrated upon the lines previously proven in top-cross trials, and upon the initiation of a new programme at Endebess to serve this special ecological area at the foot of Mount Elgon. In all this work, special attention has been given to selection for resistance to white blight and rust (*Helminthosporium turcicum* and *Puccinia sorghi*).

A series of ecological trials was made in six different zones in the district to determine the need for sub-centres for future work and to find farm stocks of maize yielding well in a variety of conditions. Due to the dry season, early types had undoubtedly an advantage this year and this is the reason why the Kitale Synthetic I did relatively better than previously. It out-yielded the station maize in seven out of nine trials by a mean value of 10 per cent.

MACHAKOS—MAIZE AND SORGHUM

This was the first full year of the new programme for better cereals for the drier areas. It was noteworthy that both seasons at Machakos produced unusually good rainfalls in no way typical of the area. A careful study of rainfall data for the last 40 years showed that reliable falls occur only in the period March-May and November-December, thus stressing the great need for quick maturity in crops for such conditions. As originally defined, the scope of the work was to cover maize and sorghum but bulrush millet has now been added. The general aims are earliness, good yield, white grain, resistance to drought, to birds, and also, in the case of sorghums, to weevils.

The first two seasons have been largely occupied by observational work on large collections of imported varieties from the widest range of sources. Amongst over 500 maizes, some varieties have shown the degree of earliness that is being sought (three-four months maturity) and a reasonable level of yield. Higher yields were given by long-season types, but these could not have matured in a more normal season. As a result of these observations, two varieties from Tanganyika are being considered for direct issue and are now in trial; these are Taboran and a similar stock known as Read's Early. Based on these, a crossing programme has been undertaken to examine the potential yield response in a range of other short-season maizes and to provide source material for developing new lines.

By contrast, the preliminary work on sorghum has been disappointing. What is required is quick maturity combined with a white grain of good palatability. The great difficulty is bird damage, which is extremely severe on such white-grained types. The requisite degree of earliness was found in some of the Hegari varieties and American hybrids, but these are all red-grained and therefore unacceptable locally; they were, however, less damaged by birds. The best yields were given by red-grained types from elsewhere in Kenya: the local Machakos collection was too slow. As a result of these observations, further work has been of a limited nature and is based on (a) low-altitude trials of two white-grained Ukiriguru stocks (SUK 1 and 42 B) together with local Mwembe and (b) formation of a collection of selected varieties with characters of merit. Sowings of millet in the April rains suffered too much rust and cold weather,

but a range of 90 stocks was sown in November with greater success. At the same time, two promising stocks of awned and long-headed millet, were multiplied on acre plots.

COAST—MAIZE RESISTANCE TO POLYSORA

The programme was restricted by illness, but the multiplication of the first stock of maize resistant to *Puccinia polysora* was undertaken on two acres. A count of susceptible plants showed one plant in 68 to have developed the rust. This stock was derived from straight crosses of local maize to Central American material containing two separate genes for resistance (Rpp 1 and Rpp 2); therefore, some susceptibles must be expected by recombination.

The back-crossing programme mentioned in some detail in the 1956 report had to be held over during the year. As explained, this latter work now concentrates on the exploitation of gene "Rpp 2" which confers resistance to both races of this disease so far known in East Africa.

RELEASE OF NEW MAIZE

The first Kitale Synthetic was under further trial and selection during the year and has now been released for 1958. It was formed from the Kitale Station stock which is a "Kenya flat white" maize, and closely resembles this parent type. It has out-yielded station maize by an average of 10 per cent this year and has been favoured by the rather drier season.

An appropriate notice releasing this Synthetic, and advising its restriction to the Trans Nzoia District, was published in the local press and will also be appearing in the *East African Agricultural Journal*.

V—Special Investigations

WHEAT QUALITY

Following upon the disappointing results of the previous years, due to wet harvests, conditions were much better in 1957 and some excellent wheat samples have been obtained. Damage by rust was prevented by the use of chemical sprays and results of the first quality tests are promising. The work continues to be undertaken in co-operation with E.A.A.F.R.O. and Unga Ltd., and will be presented in full as soon as conclusive results have been obtained; it seems best to reserve comment at this stage.

RUST CONTROL

Two rust control sprays (Zineb and Maneb) were used in 1957 and gave encouraging results. They were primarily used to protect the wheat quality trials mentioned above, but in addition a simple comparison experiment was laid down on a multiplication plot. The yield response in the latter was considered to be in excess of the direct effect of the rust control. So far as field crops are concerned, these chemicals were applied four times in the life of the crop and it is yet uncertain to what extent such treatment may be effective or economic on a farm scale. Further trials to examine the latter proposition are to be undertaken.

VI—Acknowledgments

The help given by members of the staff of E.A.A.F.R.O. and Unga Ltd., on matters of mutual interest is again readily acknowledged. From overseas, much further help and material has been forthcoming, especially as a result of the study leave spent in Mexico and Central America under the auspices of the Rockefeller Foundation. Finally, grateful acknowledgement is made to Messrs. Rohm and Haas of Philadelphia for the offer and gift of rust control chemicals for experiment in Kenya.

H. C. THORPE,
Senior Plant Breeder.

THE ANNUAL REPORT OF THE COFFEE RESEARCH STATION, RUIRU, 1957

The year's weather was remarkable for exceptional rainfall in January, followed by heavy long rains in the East of Rift coffee areas. As in the previous year, however, the unseasonal rain proved a mixed blessing; it allowed a rapid recovery from the effects of crop borne through a poor short rains and in the presence of heavy defoliation due to leaf rust and leafminers, but favoured a return of the rust epidemic for the third successive year. Conditions subsequently differed from 1956 in that soil moisture was generally plentiful throughout the year. Consequently, crops were up to expectation in weight despite heavy leaf-fall in the third quarter, although quality was generally poor.

In the West of Rift and Rift Valley coffee districts the latter half of the year was characterized by an exceptionally long period of drought, which adversely affected yield and quality except in the most favoured regions.

RAINFALL AT THE DEPARTMENT'S COFFEE STATIONS DURING 1957

	Coffee Research Ruiru	Scott Agric. Laboratories	North Kitito Estate, Makuyu	Kitale Expt. Station
January	8.35	9.04	5.37	2.25
February	0.64	1.48	0.49	0.36
March	1.91	1.23	2.99	2.89
April	12.65	8.82	8.93	6.51
May	15.99	13.24	11.01	9.23
June	2.64	1.84	0.64	3.86
July	0.48	0.34	0.17	5.01
August	0.35	0.34	0.26	6.25
September	1.27	1.20	0.55	0.60
October	4.09	2.35	2.42	0.73
November	6.42	6.48	6.95	1.94
December	3.87	2.31	4.64	0.92
Year's Total ..	58.66	48.67	44.42	40.55
No. of Days Total	128	111	106	136

The level of coffee berry disease infection was notably higher than hitherto during the year, an increase which is attributable to the unseasonal rainfall in the first quarter, followed by copious long rains. The lines of study pursued by the Coffee Berry Disease Research Unit, as reported elsewhere in this volume, have led to the development of effective chemical control measures which will be more than welcome to growers whose coffee is subject to the disease. It is heartening to learn that the disease, so long a scourge in the wetter and colder zones of the Colony, has yielded to intensive investigation.

Research into the problem of drying coffee by artificial means, without loss of quality, was carried a stage further during the year. Laboratory and field studies conducted by Mr. J. F. McCloy, Senior Scientific Officer of the East African Industrial Research Organization, led to important conclusions which are bound to exert a profound influence upon the practical application of machine drying of high quality coffees. It was found that there are two paramount factors in the retention of quality during drying. Exposure to sunlight is essential to the development of the desired blue colour of the bean and to bleach the silverskin.

Trials demonstrated that it is permissible to reduce the period of exposure to sunlight by only a small fraction of the total drying time without loss of quality. It was shown moreover that the temperature of the bean during the several phases of drying could not be allowed to exceed certain defined limits without the risk of inducing sourness in the liquor. Full reports describing these investigations were issued periodically by the East African Industrial Research Organization and a summary of the year's work was published in the Coffee Board Bulletin.

Attacks by insect pests upon the coffee tree and its crop were a salient feature of the year. Established pests were no less troublesome than in recent years and leafminers in particular caused widespread damage. In parts of the East Rift districts, leaf skeletonisers assumed major pest status in the latter half of the year. Fortunately, effective control measures against skeletonisers were devised and widely used to good effect. Much of the Entomologist's attention was devoted to a study of leafminers: a successful control was developed, entailing a twofold attack upon adults and larvae. Antestia continued to receive attention: investigations into the details of timing and spraying techniques yielded valuable results for use by growers against antestia and lacebug.

The Plant Pathologist devoted most of his time to continuing the study of leaf rust control. Arising from this work there are now strong indications that the Kenya selection K.7 will continue to be of value in the rust endemic areas until satisfactory varieties, resistant to the three prevailing physiologic races of the rust, are available in quantity for distribution. Discoveries made concerning the mechanism of infection have an important bearing upon the approach to fungicidal control. In pursuit of these findings, field trials were initiated to determine the effect of concentration related to upper or lower leaf surface cover. The critical factor of timing fungicide applications is also being examined in the field.

In agronomic research the field of scrutiny is necessarily wide but the problem of couch grass control is one which currently must be accounted of special interest to the grower. Hand eradication has never been entirely satisfactory and relies largely upon the regular reappearance of prolonged dry weather. The cost and/or availability of hand labour, in conjunction with recurring unseasonal rainfall, has revealed the weakness of this method of control. Hence a suitable and efficient means of control by herbicides is becoming essential. The Agricultural Officer's field studies of dalapon are therefore of particular interest. Consequently, investigations centred upon the selective herbicide dalapon have been intensified. Whilst the final solution has yet to be evolved the progress which has been made is encouraging.

The Agricultural Chemist's main line of research continued to be focused upon soil nitrogen and nitrogen nutrition of the tree. It is probable that the results which have been obtained, when fully analysed and studied, will suffice to bring the project to a satisfactory conclusion. The knowledge acquired over the course of five years' continuous research on this subject has enabled the issue of detailed practical advice of considerable value for the farmer.

A better understanding of magnesium nutrition in the coffee tree has emerged from continued investigation of the problems defined in the previous year.

In African districts, an accelerated rate of planting continued during the year. A regular liaison was maintained by Mr. Hanger between the Research Station and all coffee-growing districts of Central, Nyanza and Southern Provinces.

A Leaf Rust survey of the established variety trials was undertaken in Nyanza Province and the possibility of the spread of Coffee Berry Disease into new areas was kept under constant surveillance.

The coverage of variety trials in prospective coffee zones was extended by additional trials planted in most districts. The variety trial programme is now entering a stage where valuable information is beginning to accrue, from which the pattern of relative performance may be expected to become increasingly evident from henceforward.

Progress in developing the research substations at Kisii and Meru was in hand by the end of the year, although the latter could not be started until November. It is anticipated that these stations will require some three or four years to develop before the full programme of field investigations can be initiated.

A fully comprehensive record of all investigations undertaken during the year will be included in a separate report covering the 1957/58 crop season. This report, constituting the second separate annual record of the Coffee Research Station and containing full yield data from field experiments, is scheduled for publication in September, 1958. Copies will be obtainable from the Coffee Research Station, Ruiru, or from the Coffee Board of Kenya, Etco House, Nairobi.

P. A. JONES,
Senior Research Officer.

ANNUAL REPORT OF THE PLANT PATHOLOGIST/ PHYSIOLOGIST, COFFEE SERVICES, 1957

Leaf Rust Studies

Investigational work this year has largely been devoted to problems of leaf rust (*Hemileia vastatrix*) control. The studies on physiologic races, commenced last year, have been continued. The main problem has been the determination of the causes of Rust attacks on K.7. In one group of cases, segregation of susceptible types was the cause, whilst in another group it was attack by D'Oliveira's Rust Race I. Field observations suggest that although this latter is likely to be a serious menace to coffee growing in the lower areas of Nyanza and probably eventually elsewhere, K.7 still remains less affected by rust attack than other varieties and may continue to be of value until satisfactory varieties resistant to Races I, II and III are available. Further, apparently the susceptibility of K.7 to Race I varies with climate. This may be the reason it has remained free of attack in certain areas.

Studies of the factors influencing germination and penetration have been carried out. In confirmation of the findings of earlier workers it was found that spore germination is strongly inhibited by light and that a water film is essential. Germination takes about three hours at 23° C. and penetration commences after seven hours. In the field, it is thus apparent that the leaves must be wet from not later than 10 p.m. for penetration to occur, and this was confirmed in inoculation experiments on trees growing in the open.

An experiment has confirmed that spores are only likely to land on the upper surfaces of the leaves and that they reach the under-surface by rain washing and splashing. It was found that during this process, sufficient copper may be picked up from copper fungicide deposits on the upper surface of leaves to inhibit spore germination when these droplets are splashed on to the under-surface.

Tests of two sprays expected to have some effect on rust development after infection did not give encouraging results.

A field trial of various fungicidal sprays applied just prior to the long rains for control of rust was carried out. Magadi Ash Burgundy was used at $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 per cent and Perenox at the same copper contents, each being contrasted for application to upper surface as against lower surface of the leaf. Tests of Kaptan, Fermate and Oleocuvre (at the $\frac{1}{2}$ per cent equivalent, copper basis) were included at one concentration only. The results indicate that considerably enhanced control is obtainable by the higher concentrations of Perenox and Burgundy and that these are effective also on the upper surface of the leaf. Kaptan, Fernate and Oleocuvre produced about the same control as $\frac{1}{2}$ per cent Burgundy.

Arising from the foregoing, two further trials were started towards the close of the year to investigate the concentration and time of application of sprays and their effect upon control of leaf rust, viz. :—

Burgundy mixture, Perenox and Blitox were compared at concentrations (equivalent to Burgundy) of $\frac{1}{2}$, 1 and 2 per cent applied to the upper and lower leaf surfaces. Thus the single and interacting effects of type of spray, concentration and leaf surface (upper or lower) are subject to study in relation to protection against leaf rust.

The second trial is designed to yield answers to the controversial question of timing and incorporates four times of application when anti-rust sprays may be expected to exert control over the level of infection. The times included are pre-short rains, post-short rains, pre-long rains and four weeks after the first infective weather of the long rains.

Anti-Leaf-Fall Spraying

No additional work on "tonic" spraying has been initiated. The trial of copper and non-copper and hormone spraying and copper dusting received its final spray applications. Hormone spraying again produced little if any decrease in leaf-fall, whereas Fernide has been very effective. A rust recording suggested that the treatments in which a good control of leaf-fall had been obtained were heavier in rust infection.

In collaboration with the Agricultural Officer (Investigations) studies of improved methods for assessing cover produced by spraying machines have been carried out and tests were commenced on the "Conomist" spraying machine of Kent Engineering & Foundry Ltd. Messrs. Yeo and Coutts of the Colonial Pesticides Research Unit carried out droplet size spectrum determination on a number of spraying machines at the station early in the year.

Growth Recording

In the growth recording blocks, as in 1956, the frequent heavy showers in February and March caused the trees to start growing very early and a peak was reached before the long rains proper commenced, both at the Coffee Research Station and at the Scott Laboratories. At the former, as might have been expected, irrigation had little effect, but shading has considerably increased the growth rate, without affecting the general pattern of the growth curves. Records of numbers of growing points and of flowering have been commenced.

R. W. RAYNER,
Plant Pathologist/Physiologist.

ANNUAL REPORT—ENTOMOLOGIST (COFFEE SERVICES), 1957

General

Attacks of Leafminers, *Leucoptera meyricki* Ghes. and *Leucoptera coffeina* Washb. occurred on many estates in the Central Province, mainly towards the end of the year.

Leaf Skeletoniser, *Epiplema* (*Leucopsema*) *dohertyi* Warr. continued to do damage on estates in Ruiru and Thika. Where control measures were taken, malathion 50 per cent emulsion concentrate applied by tractor-drawn machines at a rate of two pints per acre, gave good control of these moths and their larvae. Lead arsenate similarly applied at a rate of 2½ lb. per acre also gave excellent control of the larvae.

Few outbreaks of Antestia, *Antestiopsis* spp., were noticed during the year.

The coffee lacebug, *Habrochila ghesquierei* Schout., continued its spread in Kiambu and had reached a few estates in Ruiru by the end of the year.

Tip borer, *Eucosma nereidopa* Meyr., continued to do damage to berries and terminal growth in Upper Kiambu. Although studies on biology and parasitism were continued, no practical control of this pest was evolved.

White stem borer, *Anthores leuconotus* Pasc., continued to do damage in coffee-growing areas prone to infestation by it. With widespread and concerted action in such areas, using the dieldrin banding method of control, there was real prospect of bringing this insect to the point of extinction.

Scale Insects.—An unusually large area of coffee was found to be infested by the brown bark scale, *Lecaniodiaspis erratica* de Lotto, on an estate in Kiambu. Treatment with malathion was, however, effective on this insect, particularly on the nymphs. The fringed scale, *Asterolecanium coffeae* Newst., caused trouble on some estates but was controlled with oil emulsion sprays. The coffee mealybug, *Planococcus kenyae* Le Pelley, was noticed sporadically throughout the year but no serious attacks were found.

Other Pests.—An unusual item was an attack of a large slug, *Trichotoxon* sp., on several estates in the Donyo Sabuk area. The slugs did damage by removing the pulp from ripe berries on the trees, and the pulp appeared to be palatable to them whether still red or completely dried. On one estate, 150 acres were infested by them. Where control measures were taken, metaldehyde baits were effective.

Insecticides

With the demonstration of the value of the insecticides malathion and diazinon against many serious coffee insect pests, particularly the sucking insects (*Hemiptera*), the Leafminers, *Leucoptera* spp., and other moths, the coffee grower is now in a much better position to apply effective measures to control most of the pests he encounters. This position is now even more favourable, in that better spraying equipment is available in a variety of forms to suit his needs. It is now possible almost to eliminate insecticides of long residual action from the spraying recommendations, so that there is less fear of interference with the complex of beneficial insects associated with coffee. Insecticides of long residual action, when applied as spray-bands against ants attending scale insects or White Borer, are still essential, but are not recommended as foliage sprays.

A comprehensive taint trial carried out with a range of insecticides demonstrated that no taints were imparted to coffee liquors with parathion, malathion or diazinon used at normal concentrations. A lindane wettable powder formulation did, however, impart "bricky flavour", an undesirable taint associated in the past with the use of B.H.C. insecticides.

Research on Insect Pests of Coffee

1. ANTESTIA, *Antestiopsis* spp.

Experimentation with malathion against *Antestia* continued and recommendations for its use were issued. A full account of this work was published in the Bulletin of the Coffee Board of Kenya in June, 1957. Growers who followed these recommendations were invariably successful in obtaining good control of this serious pest.

2. LEAFMINERS, *Leucoptera meyricki* Ghes. and *L. coffeina* Washb.

Experiments with insecticides and investigations into the life histories of these insects were pursued. Resulting from these studies it was found possible to achieve control of the moths as well as larvae within the leaves with diazinon, and to control the moths with malathion. Suitable spray-timings were determined and recommendations for controlling these pests were published in the Bulletin of the Coffee Board of Kenya in December, 1957.

2. COFFEE LACEBUG, *Habrochila ghesquieriei* Schout.

No infestations suitable for experimentation were found during the year. However, before completion of this report, a range of insecticides was tried against it. Of these, parathion was the best, but was very closely followed by malathion. In view of the hazards to spray operators associated with the use of the former insecticide, malathion is recommended for the control of lacebug. Two sprayings were found necessary, the second to be applied 21 days after the first in order to eliminate the population resulting from the relatively few eggs not killed by the first spray application. Malathion should be applied at a strength of one pint of the 50 per cent emulsion concentrate in 40 gallons of water on each occasion.

In a trial of aerial spraying against *Antestia*, it was found that the two pints of malathion concentrate applied per acre by this means, also had good effect on lacebug. The mortality of eggs was not, however, so great as is achieved by using ordinary spraying machines. It was, nevertheless, demonstrated that this method could afford a means of rapidly containing an attack. Research continues on this pest.

4. WHITE BORER, *Anthores leuconotus* Pasc.

Field experiments evaluating the efficiency of dieldrin spray-bands were continued. It has now been demonstrated that three applications of $\frac{1}{2}$ per cent dieldrin applied previous to consecutive rains, i.e. over a period of 18 months, completely eliminates boring larvae. Dieldrin spray-banding is now recommended to growers whose coffee is infested by this insect.

Miscellaneous Items

Much assistance was received from the Commonwealth Institute of Entomology in the identification of insects, and this is gratefully acknowledged.

Mr. G. de Lotto rendered much assistance in identification of scale insects and mealybugs.

As usual, many growers permitted experiments to be done on various pests on their estates during the year. Their assistance in this aspect is most gratefully acknowledged.

D. J. McCRAE,
Entomologist.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST (COFFEE SERVICES), 1957

Soil Nitrogen and Related Studies

Field results with nitrogen and mulch combinations during 1956/57 have shown that whereas the increased growth obtained in response to mulch treatment during the long rains has provided a growth curve with exactly similar pattern to that obtained with the control, unmulched treatment, the nitrogen fertilizer treatments have modified the shape of the growth curve significantly. From this work, coupled with the results of previous soil studies, it seems likely that the maximum application of nitrogen in mature coffee should be split during the long rains and that one-half should be applied during the first third of a normal period, i.e. first week in April, and the full dressing completed by application of the second half early in the last part of the rains, i.e. mid-May.

These growth data in the presence and absence of added nitrogen, can be related to actual nitrate nitrogen trends in the soil during the rains period and particularly with the low values found towards the end of the rains. Laboratory incubation, under standard conditions, of wet soil samples taken at the end of the rains period suggest that low nitrate nitrogen values are not only related to rapid leaching from the upper soil profile and to uptake by the coffee crop, but also to an inability of the soil to produce large quantities at this time. Apparently, the nitrogen mineralization process slows down considerably following a sustained period of adequate soil moisture. Easily assimilable organic matter is probably less readily available towards the end of a long rains period and may account for this condition.

Further laboratory studies to investigate the influence of pre-drying the soil sample in preparation for incubation, upon its performance under standard conditions, have pointed to a second mechanism which results, directly or indirectly, in large increases of ammonia nitrogen. This in turn is rapidly nitrified when the soil is remoistened.

Topsoil temperatures of 45-55° C. are often recorded in the field during the hot, dry months of January and February; pre-drying soil samples overnight at an air oven temperature of 50-55° C. has consistently resulted in very high ammonia nitrogen values eight days after rewetting the samples.

Under field conditions the accumulation of ammonia nitrogen takes place as soon as the soil moisture level falls much below the permanent wilting percentage (Robinson, *J. Agric. Sci.*, 1957, 49, 100). This formation of ammonia nitrogen has been observed to take place to a depth of 24 in. under field conditions. Subsequently, following the short rains season and particularly when the topsoil has dried out, soil temperatures are high and this partial sterilization effect, which in some manner results in releases of readily assimilable organic nitrogen, is operative. Both these mechanisms would appear to be related to the large nitrate nitrogen flush that occurs when sufficient rainfall is received to wet the soil adequately, i.e. usually in the following grass rains or early long rains, after such a dry, hot period.

More recently, laboratory incubation experiments to examine the influence of some of the essential elements of plant nutrition on natural soil nitrogen mineralization have been conducted. Using the subtractive technique of Webb, early results have failed to show that the absence of any particular nutrient, following applications of all the others to the soil before incubation, inhibits natural nitrate or ammonia formation.

Magnesium Nutrition of Coffee

The investigation of magnesium nutrition of coffee has been continued following the identification of a magnesium deficiency condition in coffee during 1956, and preliminary study of the relationship with grass mulches. (A full report of this work is to be published in July, 1958.) There is no doubt that the incidence of this condition, which is widespread, is related to the use of grass mulches in coffee, and more specifically to the increases in soil potassium which result from decomposition of the mulch. The imbalance of high potassium: low magnesium in the leaf is closely related to the high potassium and normal (i.e. but now low in relation to potassium) magnesium values in the soil.

Following this definition of the problem relating consistent mulching to magnesium uptake by the coffee tree, it has been possible to lay down two factorial fertilizer trials to study long-term methods for correcting the imbalance and to determine the yield response to such corrective treatments. Coffee estates on the Kikuyu red loam soils, and probably on other soil types as well, that have been consistently mulched with Napier grass over the past 6-10 years or longer, will most certainly need to correct this condition in the near future. A locally manufactured magnesium fertilizer which is suitable for application in coffee has been put on the market recently.

Leaf analysis results for samples collected in the preliminary observation magnesium trial which started in 1954, have shown that there are marked and significant trends in leaf potassium, calcium and magnesium contents from month to month during the year. These trends appear to be related to growth periods and cropping levels.

Chelated Plant Nutrient Applications to Coffee

A trial conducted during the year on mature multiple stem coffee to which applications of an iron chelate formulation were made, did not provide any statistically significant yield increases for the treated over the untreated (control) trees. However, as there was a non-significant yield difference of +4 cwt. clean coffee per acre in favour of the higher rate of iron chelate application, the trial is being continued in 1958 with reapplication of the treatments.

A second trial on newly planted coffee, which started in 1956, has not yet reached the bearing stage. In this, a total of five different chelated nutrients plus a fritted glass trace element mixture, are being compared in the presence and absence of cattle manure at planting time. Stem girth measurements taken in 1957 did not show any statistically significant treatment differences, but will be used to calculate incremental girth data following further measurements in 1958. The first crop yields will not be recorded until 1959.

Cultivation and Cropping on Vlei Soils

It would seem, from experimental crop yield results obtained since 1954, that Camber Bed cultivation of ground-water (vlei) soils (Refer. *E. Afr. agric. J.*, 1955, 21, 69) will have an economic place in the farming pattern where soils of this type are found. Napier grass production for coffee mulching has been satisfactory provided nitrogen plus phosphorus fertilizers and/or cattle manure are applied. Thus, to date, it has been shown in this trial that economic crops of maize and beans can be grown on these areas after cultivation in this manner, as well as Napier grass. More recently, the pineapple crop records have been completed and it is apparent that substantial yields are possible, i.e. 26-28 tons per acre of fruit in the plant crop; 20-22 tons per acre of fruit in the first ratoon crop. A detailed report will follow in due course.

A Comparison of Three Types of Phosphorus Fertilizer on the Kikuyu Red Loam Soil

Three trials were initiated in 1955 and two of them were completed during 1957, to compare the effect on crop yields of superphosphate, hyperphosphate reno (North African rock phosphate) and basic slag applied at equivalent rates of water and citric soluble phosphorus per acre, in the presence and absence of a nitrogen fertilizer. The crops in these trials were: Napier grass, Trial I; maize for silage (long rains), white haricot beans (short rains), Trial II; and three species of ley grasses, Trial III.

Trial III has not yet been completed, but to date no yield responses to treatments have been recorded in individual seasons. Trials I and II have been completed and since the responses to treatments are largely the same qualitatively for the three crops, the following comments apply generally. It should be noted here that the phosphorus fertilizers were applied in the long rains only each year and that the bean crops in Trial II were grown on residual fertilizer only. Superphosphate treatments were overall slightly better than the basic slag treatments and produced significant crop yield increases, whereas hyperphosphate reno produced very little response in any of the crops and yields from this treatment lagged well behind the others. Superphosphate with nitrogen appeared to interact positively for the Napier grass and silage maize crops, whereas yield responses to the basic slag plus nitrogen treatment were often lower than basic slag applied alone. Nitrogen fertilizers produced no yield response, either alone or in combination with the phosphorus fertilizers, in the bean crop, and by itself had no significant influence on either Napier grass or silage maize yields.

Miscellaneous

During the year there have been an increasing number of analyses made on coffee leaf samples collected from African-producing areas. The wide variety of soils and climatic conditions is providing examples of visible malnutrition symptoms which have not hitherto been observed in the European plantation industry. Appreciable nitrogen and phosphorus deficiency conditions are sometimes observed in more mature African coffee at the back of the broader terraces. Of more frequent occurrence is the condition of magnesium imbalance in the presence of heavy crops, resulting very largely from heavy and consistent mulching. With the substantial benefits which are derived from mulching, it seems likely that some attention will need to be paid to the use of magnesium fertilizer in the near future.

A series of soil and coffee leaf samples from the Elgon Nyanza area were examined for boron content in respect of a severe incidence of Elgon dieback disease. No evidence of any relationship was recorded in this instance.

It seems probable that there will be an increase in the numbers of samples of this type received for analysis over the next few years.

J. B. D. ROBINSON,
Agricultural Chemist (Coffee Services).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (COFFEE LIAISON AFRICAN AREAS), 1957

Coffee Variety Trials in African Areas

During the year, the first valuable results were obtained from the large number of variety trials established in preceding years. Detailed yield data are available only from the larger variety trials, but a wealth of information of an observational character was obtained from the single tree plot miniature trials.

LOW ALTITUDE VARIETY TRIALS

In most East Rift districts the ability of individual varieties to resist leaf rust (*Hemileia vastatrix*) is of paramount importance below an elevation of about 5,400 ft. Similarly, in Nyanza Province, rust resistance is essential where coffee has been planted below about 5,700 ft. In Nyanza Province the resistance to leaf rust shown by the variety K.7 has been outstanding. A comprehensive survey was made during the year to determine the incidence of leaf rust on the many varieties under trial. The major reason for the increased susceptibility of K.7 to leaf rust was due to infection by D'Oliveira's physiologic Race I in Elgon and North Nyanza. Even where Race I is known to exist there is still a valuable degree of partial resistance shown by some K.7 plants.

The first results from the rust exposure trials planted in 1956 should become available in 1958. These trials will be extended as new varieties, which are reputed to have some rust resistance, become available.

In Fort Hall the variety S.L.6 has shown good resistance to leaf rust and seed has been distributed for the first time on a commercial scale; the variety Kenya Selected has also exhibited some resistance.

MIDDLE ALTITUDE VARIETY TRIALS

Results from variety trials situated between 5,400 ft. and 5,800 ft. in Fort Hall and 5,000 ft. and 5,700 ft. in Embu have shown that the varieties S.L.28 and S.L.34 are best suited to conditions where neither leaf rust (*Hemileia vastatrix*) or coffee berry disease (*Colletotrichum coffeanum*) are a serious factor. In Meru District the variety S.L.28 has outyielded consistently the local selection of Meru Kents.

HIGH ALTITUDE VARIETY TRIALS

High altitude variety trials were planted in Nyeri District in 1957 with varieties which may exhibit some resistance to coffee berry disease. It is hoped that some selections of Blue Mountain may be found that are capable of producing an economic coffee crop for African growers without the necessity of using fungicidal sprays against the disease.

The first results from the variety trials at Githunguri in the Kiambu District have shown that the variety Blue Mountain grows slowly in the first years after planting when compared with the variety S.L.34. The varieties Ke.20 and S.L.34 have shown a high degree of resistance to "Hot and Cold" in trials in Machakos District, Kiambu District and the Nandi District.

In the higher rainfall areas of Nyanza Province, the growth and cropping propensity of Blue Mountain is far better than in the lower rainfall conditions in Central Province.

THE IMPORTANCE OF VARIETY TRIALS IN RELATION TO COFFEE DEVELOPMENT

The present coffee policy in many African districts is based partially upon information gained from the variety trials which were planted prior to general commercial development in each area. In 1957, the areas covered by variety trials were further increased: trials were planted for the first time in Kitui District and in other areas where conditions may be expected to be marginal for coffee. When the results from these new trials are available it will be possible to assess the lower and upper altitude limits for coffee development in African land units throughout Kenya.

B. F. HANGER,
Agricultural Officer (Coffee Liaison African Areas).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (COFFEE SERVICES), 1957

Cultivation and Weed Control

The outstanding feature of both the cultivation and the rotavator trials has been the consistency with which clean weeding throughout the rains has led to substantial yield increases. The percentage response in 1957 may be summarized as follows:—

			No weeding during the Rains	Clean weeding
			<i>per cent</i>	<i>per cent</i>
Cultivation Trial	..	..	100	132
Rotavator Trial	..	..	100	142

On neither trial was there any apparent connexion between the implement used for cultivation and the yield of coffee cherry.

The herbicidal trial (commenced in 1954) was concluded at the end of 1957, since the following points had been established:—

- (a) Chemical weed control is as beneficial to coffee yields as clean weeding with implements.
- (b) A “bricky flavour” may be introduced into the liquor reports if a P.C.P. fortified oil emulsion is used as a herbicide in coffee.
- (c) Dalapon and 2,4-D can give a good control of general weed growth.

Herbicide work in 1957 was directed towards the eradication of couch (*Digitaria scalarum*) as a coffee pest. As a result of work to date, the most satisfactory sequence of operations is thought to be:—

- (i) All old weed growth to be cut to the ground and the trash removed from the area to be treated.
- (ii) At a time of active couch growth, such as occurs in the first half of the rains, spray with a mixture of 5-7 lb. dalapon in 40-80 gallons water/acre.
- (iii) Do nothing to the area for two months, then spray regrowth of couch with a mixture of 5 lb. dalapon/40 gallons water using no more than $\frac{3}{4}$ pint per 81 sq. ft. (one tree area at 9 ft. $\times$ 9 ft. planting).

Mulches, Manures and Fertilizers

In 1957 there was no positive yield response to the use of mulch on any trial on which this treatment was included. It is likely that there are two reasons for this unusual state of affairs:—

- (i) Very heavy yields were picked from mulched plots in 1956.
- (ii) 1957 was the wettest year on the Station’s records and at no time between April and December was there a serious soil moisture deficit.

For the first time since 1952 two *debes*/tree of composted cattle manure led to a significant increase in yield of clean coffee (+ 14 per cent) on Manurial Trial I, and a similar increase was recorded on Manurial Trial II where the rate of application is four *debes*/tree. Since this latter trial commenced in 1950 the only yield increase attributable to this treatment was in 1955 (+ 6.4 per cent)—not statistically significant.

In 1957, considerable responses to nitrogenous fertilizers were recorded on all trials in which they were tested.

1957 CHERRY YIELD AS A PERCENTAGE OF THE "CONTROL" YIELD IN EACH TRIAL

I.b. Nitrogen/acre .. Urea equiv. lb./acre	Fertilizer	11.5 25	23 50	46 100	69 150	92 200	138 300
Manurial Trial	Urea			104			
I	Sulphate of Ammonia.			114			
II	Urea					128	
III	Urea			116		122	
IV	Urea				130		147
Urea Spray Trial							
Soil Application ..	Urea		105	127		116	
Spray—High Vol.	Urea		121	92			
Spray—Low Vol.	Urea	119	108	122			
Mulch Trial ..	Urea			125			
	Nitrate of Soda			100			
	Half of each ..			102			

For the eleventh year in succession, use of a phosphatic fertilizer has not increased the yield of coffee. In 1957, basic slag was used for the first time in the hope that the coffee might derive some benefits from the various constituents of the fertilizer other than phosphate.

Anti-Leaf-Fall Spray Trials

At the Coffee Research Station, Ruiru, the yield level on Machine Spray Trial I was low and the value of anti-leaf-fall spraying to reduce biennial bearing well demonstrated: after the good crop of 1956 (14.84 cwt. clean coffee/acre) the unsprayed plots produced a very small crop in 1957 (1.5 cwt. clean coffee/acre approximately) and the best spray treatment increased this yield by 450 per cent.

From Machine Spray Trial II in which an airblast machine is compared with a low volume sprayer, yield results were rather surprising as they did not follow the same order as the leaf fall counts of the previous year which is normally the case in trials of this sort. In 1956, the least leaves fell from the trees sprayed with a "Micron" low volume sprayer, delivering 10 gallons/acre of a spray containing 6.8 lb. of a 50 per cent copper formulation/100 gallons. In 1957, the yield from this treatment was 94 per cent of the unsprayed plots, while the "Micron" treatments, using spray concentrations of 13.6 lb. and 34 lb. of the same formulation in 100 gallons, both yielded 131 per cent of the unsprayed treatment, although they had been less effective in controlling leaf fall in 1956.

On the trial at Makuyu, yield increases of between 53 per cent and 77 per cent were recorded from the various spray treatments. At Kitale the best treatment—a spray applied in May—gave 25 per cent more cherry than the unsprayed controls.

Pruning

The coffee yields from Pruning Trial I in 1957 confirmed the results obtained in previous years. Pruning Trial II was laid down on young coffee planted in 1956. The treatments on this trial are designed to give detailed information on the effect on yield of various methods of multiple stem pruning.

Irrigation

The 1957 yields from the main irrigation trial, which was begun in 1956, have shown no benefit from the various methods and quantities of watering. This is not surprising because the period since the commencement of this trial has been exceptionally favourable to the soil moisture supply.

The response to the offer of an irrigation advisory service has been small, but experience has been gained in its operation which should prove useful in expanding the service in less favourable years.

Variety Trials

A start has been made on the correlation of information now accumulating from the Colony-wide variety trial programme which began in 1950.

Nursery Work

CUTTINGS

The best results were obtained from wedge-shaped nodal cuttings of two nodes length, prepared from semi-ripe wood. Indolebutyric acid powder (of 5 p.p.m. dilution) applied to the base of cuttings has been shown to stimulate earlier root formation, but failed to increase the percentage of cuttings eventually rooted. Using the method described, the average of cuttings struck exceeded 90 per cent three months later. Many other types of cuttings were tested but the results were inferior to the foregoing.

AIR LAYERING

Experiments with air layering were disappointing; only a very small percentage of layers produced roots and subsequent establishment of these plants was difficult.

VINYL RESINS

Vinyl resin (VL 600) was sprayed on to the leaves of the coffee cuttings at the time of insertion in beds in order to minimize moisture losses due to transpiration. Although the rooting percentage of cuttings treated with Vinyl Resin was not greater than the control, the time required for rooting was reduced by two or three weeks.

VL 600 was also applied to the leaves and/or the roots of coffee seedlings immediately before they were transplanted to the field during the dry season (16th June, 1957). The rate of plant mortality was high for all treatments tested, but the least number of deaths was recorded (15th October, 1957) from the treatment in which the tops alone were sprayed with the Vinyl Resin. The tops and the roots of all living plants were weighed on 18th January, 1958. This revealed that digging the roots had reduced the amount of growth in six months while spraying the tops had enabled both the roots and the tops to put on more growth than was possible in the absence of any treatment with VL 600.

COFFEE SEED GERMINATION TESTS

Germination tests were in progress throughout the year to check on the viability of seed being sold commercially and to compare the effect of storage conditions on coffee seed germination capacity. No definite conclusions were derived from these tests, but there were indications that the rapid drop in coffee seed viability about March, irrespective of the age of the seed, is associated with dry atmospheric conditions normally associated with that season.

Machinery

Grass-cutters.—A small demonstration of grass-cutters was arranged in February, 1957, with the co-operation of local firms. Unfortunately, none of the machines on view appeared completely suitable for the task of cutting Napier grass in a mature stage.

Rotary Hoes.—During the year, notable for the increase in numbers of modified rotary hoes being used for weed control in coffee, models of two makes of rotary hoe were tested for use in coffee.

Sprayers.—Aided by expert advice from the Colonial Pesticides Research Unit, Arusha, a start has been made on detailed testing of spraying machines. By the end of the year a satisfactory technique had been developed which it is intended shall be employed to pursue the study of spraying equipment, since the latter is rapidly becoming the most important operation in coffee plantation management.

Factory

Following the installation of an Aagaard pre-grading machine and a dry cherry feed in the Coffee Research Station factory, tests were carried out to compare the quality of parchment coffee produced from such an installation with that produced by the Coffee Demonstration Farm layout which employs a siphon cherry feed, a rotatory sieve and pre-grading channels before the fermentation tanks.

Numerous liquor samples taken in 1956 revealed no consistent difference in the quality of coffee processed by the two types of factory.

In 1957 a large number of samples were taken from the two factories for the measurement of such physical features as bean size and density. The results of these comparisons may be summarized as follows:—

				Coffee Research Station Factory	Coffee Demonstration Farm Factory
FIRSTS—					
Hulling loss, per cent	..	..		18.28	18.25
Grade A, per cent	..	..		69.20	71.66
Grade B, per cent	..	..		11.08	11.99
Remainder, per cent	..	..		19.72	16.35
SECONDS—					
Hulling loss, per cent	..	..		18.99	18.07
Grade A, per cent	..	..		68.15	67.50
Grade B, per cent	..	..		10.67	12.55
Remainder, per cent	..	..		21.18	19.95
LIGHTS—					
Hulling loss, per cent	..	..		26.11	39.48
Grade A, per cent	..	..		52.21	51.59
Grade B, per cent	..	..		15.24	14.65
Remainder, per cent	..	..		32.55	33.76

Again there is no clear difference between the systems though there is a suggestion that the Demonstration Farm is giving a better separation of Seconds from Firsts.

Grasses for Mulch Production

Thirteen species and strains of grass thought to be suitable for mulch production have been planted in $\frac{1}{4}$ -acre plots. Records have been kept of yields of green and dry matter and the area of coffee which can be effectively mulched with the material from the $\frac{1}{4}$ -acre plots. Notes have been kept of the persistence of the various grasses when laid on the ground to a regular depth of 6 in.

The following grasses are included:—

Pennisetum purpureum ex Cameroons. Local Hairy Napier Grass.
Uganda Hairless—Clone S/4.

Hyparrhenia rufa, *H. ruprechtii*, *H. cymbaria*, *H. sp.* ex S.A.L., 11/4.

Cymbopogon validus, *C. afronardus*.

Sorghum sudanense.

Panicum maximum ex Mackinnon Road.

Panicum coloratum var. *sensulatum*.

Cynodon sp. (Giant Cynodon).

The various strains of *Pennisetum purpureum* outyielded all other grasses both in green matter and dry matter weight per acre per year (maximum of 86.65 tons green matter and 17.15 tons dry matter per acre in two cuts). *Cymbopogon validus*, *C. afronardus* and *Hyparrhenia* sp. ex S.A.L. 11/4 all gave moderate yields combined with good persistence as a mulch. In six months a 6-in. layer of the *Cymbopogon* grasses decreased in thickness by only 2 in. while layers of mulch from the *Pennisetum purpureum* grasses lost 5 in. in thickness during the same period.

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THE ANNUAL REPORT OF THE COFFEE BERRY DISEASE RESEARCH UNIT, 1957

During the year, the full results of the 1956 series of field experiments became available and are summarized below, together with the conclusions drawn from them.

I. JANUARY-MARCH, 1957: *Results of the 1956 Field Experiments, and their Interpretation*

Experiments were initiated in March, 1956, on several estates in each of four localities. These included Upper Kiambu, North Lumbwa, Nandi/Kapsabet and Cherangani. In June the experiments were extended to Mount Kenya (Nyeri) area, where it was planned to investigate mid- and late-season losses attributable to coffee berry disease. The experiments, of varying design, were directed mainly towards investigating the effects of time and frequency of sprays and, as such, must be regarded as being preliminary. The results of these experiments are summarized under their locality headings:—

1. *Upper Kiambu*

The results of the three 2^o factorial experiments, designed to investigate the effect of timing of sprays on the disease, clearly indicated that the most critical period for control occurred over the blossom period. 20-30 per cent increases in yield were obtained from one well-timed blossom application. No later treatments, that is, no treatment applied over the period following blossoming (May-October) gave any response.

2. *Mount Kenya (Nyeri) Areas*

Two treatments applied in July and August increased yield by 20 per cent (an equivalent increase of 2 cwt., parchment coffee). Subsequent applications gave no response.

3. *West Rift Areas*

The Cherangani trials were made invalid by the fact that expected severe attack did not materialize. At Lumbwa and Nandi, in spite of extremely variable material and irregular disease distribution, certain trends were clearly evident—early blossom applications were having an effect on what was to be considered a peak infection period, and that mid-season applications (August-October) were having an effect on a second epidemic phase.

The Kapsabet trial proved extremely informative. The responses of the different varieties are summarized in the table below, the figures given as cwt./acre.

VARIETY				Untreated	Treated	Response (= % increase)
Blue Mountain	..	..	..	1.6	3.6	125
SL 28	..	..	..	2.2	3.6	63.6
Kenya Selected	..	..	..	1.1	1.8	63.6
Series A	..	..	..	0.9	2.2	144.4
SL 30	..	..	..	0.5	1.8	260.0
SL 34	..	..	..	1.2	2.6	116.7
SL 9	..	..	..	1.7	3.0	76.5

From the above results, taken as a whole, it must be concluded that an economic fungicidal control of coffee berry disease is possible. Several other important facts were discernible. The importance of blossom applications was made clear. It could be inferred from a study of the responses that the epidemiology of the disease varies considerably for Kiambu, Mount Kenya and West Rift areas. Briefly, Kiambu figures hinted at one epidemic period centred on blossoming; West Rift hinted at two epidemic periods—overblossoming and again at any time between July and September. Mount Kenya areas showed severe attack in July and August.

The 1957 series of trials, based on these results, were carried out on the same experimental areas and sites, excepting Cherangani and Nandi.

II. MARCH-DECEMBER, 1957

More critical designs and techniques were used; for example, the use of guard rows between sprayed plots was abandoned, and screens used. Uniformity of material was the first criterion of site selection.

The fungicide trials were extended and the number of formulations to be tested increased. The Kiambu and West Rift trials received true pre-blossom treatments, and only at Nyeri was the issue complicated by virtue of a heavy November flowering which preceded the first spraying. The application of treatments went on steadily and satisfactorily in all areas throughout the season. Unfortunately, the main series of fungicide trials, sited at Upper Kiambu was completely destroyed by hail. The West Rift and Nyeri trials, unfortunately, were comparatively small ones; consequently, information on many possible formulations is, at present, lacking.

In September, the first signs of phytotoxic effects on experimental blocks which had been treated with a mercurial spray were observed simultaneously at Nyeri and Kiambu. These first took the form of an extremely delayed leaf scorch and die-back, but were later to assume a more serious set of symptoms which have since been attributed to an induced zinc deficiency. Investigations on the latter were started in October, and in November/December preliminary experiments on possible remedial measures were undertaken. These are in progress at the moment.

NOTES ON TRENDS OF THE 1957 RESULTS

The main facts emerging from the results at present at hand (final figures will not be available until February, 1958) are summarized briefly below.

1. The Kapsabet trial has given comparable results with those of 1956, though the responses have doubled and in some cases trebled. There is now no doubt that Blue Mountain is subject to severe blossom attack in certain climatic conditions, and that other varieties such as SL.28 and SL.34 are far superior in yielding capacity.

2. Kiambu experiments are giving a greater response and again this is completely confined to the blossom group of applications.

3. A secondary effect of spraying has been observed. With all formulations, the fruit size and therefore the bean size is considerably increased over that of the controls. This is probably a reflection of the increase in leaf area observed and quantitatively checked in August/September, i.e. before the secondary phytotoxic effects were manifest. The early sprays again would appear to have exercised the major effect.

It is clear from the field data that the responses are quite inexplicable on any hypothesis involving simple protection from or eradication of fruit infection. This will be referred to later in this report.

Laboratory work already begun on the relations between the fungus and climatic conditions such as temperature and humidity have been completed and 1956 results confirmed and extended. Attention has been directed to the infective process in relation to time, plant variety, temperature, humidity, the part of the plant attacked, its age, the effect of wounding, and the past history of the inoculum. The results are now being prepared for publication. Two points might be referred to here. It is clear that the observed varying susceptibility of the berries of any given variety with age and the very high susceptibility of flowers is closely correlated with spore germination rates. For example, of a particular batch of spores, only 4 per cent germinated on green berries compared with 66 per cent on flowers. On the other hand, the different susceptibility of varieties is not to be explained on this basis but seems to be the result of some difference, chemical or physical, of the epidermis of the berries.

A study of the effect of fungicides on fungal growth, infection, germination and so on has been undertaken with a view to obtaining a reasonably accurate assessment of the value of a given preparation. Very great technical difficulties were encountered but eventually a method which seems adequate was developed. All fungicides now under test have been screened in this manner and new ones listed as they become available. One, of outstanding performance under laboratory conditions, is now being tested under field conditions.

The fact that a precisely-timed series of treatments, centred round the blossoming period, has so profound an effect was unexpected and as has been pointed out previously, is inexplicable on the basis of current views. An understanding of what is actually happening is therefore called for in order to determine with precision the correct times of application in the various districts—these being known to vary.

A hypothesis has been put forward whereby the development of an epidemic in a plantation is ascribed, in the main, to infection derived from the branches, the infection derived from the crop being of subsidiary importance, except perhaps in certain districts, with extreme climatic conditions. In order to investigate this possibility, new methods for assessing the infection-potential of specific parts of the coffee tree have been successfully devised and preliminary work has given results which strongly support the hypothesis given above. Detailed study of this is planned for the next crop season.

In addition to the research work outlined above, observation of many plantations, mainly at the request of their owners, has been made and routine diagnoses carried out.

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ANNUAL REPORT OF THE GRASSLAND RESEARCH TEAM, 1957

Kitala Grassland Research Station

WEATHER AND RAINFALL

Although the total rain for the year was adequate though below average, its distribution was not good, particularly in the months of July, August and September.

RAINFALL TABLE

MONTH	1957		1956		1955	
	Rainfall inches	No. of wet days	Rainfall inches	No. of wet days	Rainfall inches	No. of wet days
January ..	0.94	7	2.12	9	1.76	6
February ..	0.15	3	3.10	6	1.23	6
March ..	3.19	12	2.56	7	0.45	4
April ..	6.75	22	5.75	20	3.49	17
May ..	9.24	20	6.85	21	4.44	13
June ..	4.66	18	2.70	18	3.19	14
July ..	4.18	12	4.72	20	4.58	22
August ..	5.96	19	7.50	21	6.18	21
September ..	1.24	9	4.46	18	6.28	24
October ..	1.22	10	4.73	17	2.83	14
November ..	2.35	14	0.56	3	1.42	11
December ..	1.77	7	0.75	6	4.87	11
Totals ..	41.65	153	45.80	166	40.72	163

Plant Introduction and Nursery Work

The plant introductions of special interest mentioned last year, namely *Onobrychis sativa* (Sainfoin), *Setaria splendida* (Giant *Setaria*), *Ronpha* grass and *Phalaris daviesii* (Davies grass), continue to show promise, and are still under trial. New plantings this year include many varieties of *Chloris gayana* (Rhodes grass), *Cynodon dactylon* (Star grass), *Panicum maximum* (Guinea grass) and *Pennisetum purpureum* (Elephant grass), most of which came from Uganda. In particular it is hoped that some good seeding varieties of Star grass will be found among these, and several of them look hopeful in this respect. Among legumes, further varieties of subterranean clover which seed well here have been obtained from Australia, and also a good variety of *Trifolium pratense* (Red clover) from the U.S.A. *Hedysarum coronarium* (Sulla), a perennial from Italy, also seems well worth further trial. The subterranean clover variety "Clare" has shown up particularly well this season, producing as much seed as "Dwalganup" and much more leaf. Seed production of subterranean clovers is still not adequate for commercial purposes, but it improves with better varieties and better methods of management and manuring. The latter seems to be particularly important.

Preliminary Grazing Trials

In the preliminary grazing trials, designed to test the persistence of new introductions under field grazing conditions, various *Paspalum* species, and varieties of *Chloris gayana*, *Melinis minutiflora*, *Cynodon dactylon* and *Setaria sphacelata* have been tested. These grasses have also been tested in the same way in combination with a variety of clovers and other legumes, to examine their

compatibility one with another. At the end of the second year of one of the preliminary grazing trials, the following have persisted and shown up well: *Trifolium semipilosum* (Kenya white clover), *Trifolium repens* (Louisiana var.), *Medicago sativa* (Hairy Peruvian lucerne), *Desmodium uncinatum*, *Trifolium rueppellianum* (Rueppells clover), and *Trifolium subterraneum* (Yarloop and Dwalganup vars. of subterranean clover). A variety of *Setaria sphacelata* from Meru also appears to be useful and persistent.

The general impression is that, once established, Kenya white clover is the best of our pasture legumes, although some others such as Louisiana white clover and subterranean clover often established more quickly. We have yet to find a better pasture grass than those already in common use, e.g., Rhodes grass, Molasses grass, *Setaria*, and Star grass. Slender Guinea grass still seems to be very promising, and there is a probability that one of the *Paspalum* species under trial may turn out to be valuable. They appear to be somewhat lacking, however, in palatability and seeding capacity.

Species and Mixtures for Leys

During 1957, herbage agronomy work has been concerned primarily with the two main types of ley which are being developed with the object of providing the maximum amount of high quality feed for livestock, for as long a period as possible during the year. These are "general purpose" leys which produce the bulk of grazing, hay or silage during the rains, and "late season" or "dry season" leys which provide a reserve of green feed during the drier months. At the same time, the influence of legumes on the yield and quality of these different types of pasture is being assessed.

Attention is now being directed primarily to the following species which have been selected for "general purpose" leys: the important grasses are *Chloris gayana*, *Melinis minutiflora*, *Panicum maximum* var. *trichoglume*, *Setaria sphacelata*, *Cynodon dactylon* and *Panicum coloratum*, and the important legumes are *Trifolium semipilosum* var. *glabrescens*, *Trifolium repens*, and *Medicago sativa*.

For "late season" leys the important grasses are *Pennisetum purpureum*, *Panicum maximum* var. *trichoglume*, *Panicum maximum*, *Setaria splendida*, and *Cynodon dactylon*, and the important legumes are *Glycine javanica* and *Dolichos* sp. nr. *lablab*.

Species Evaluation for General Purpose Leys

(1) A PRELIMINARY STUDY OF THE INFLUENCE OF LEGUMES ON THE YIELD AND QUALITY OF LEYS

This exploratory trial, which was established in 1955 and described in our 1956 annual report, continues to give interesting results. The trial includes four grasses, namely Star, Molasses, Nzoia Rhodes, and Nandi *Setaria*. Each of these is planted in three different arrangements consisting of grass alone, grass with Kenya white clover, and grass with clover and lucerne. Each of these mixtures was established with three different levels of phosphate. These are: PO, the control with no phosphate; P1 with 2 cwt. of triple superphosphate per acre in 1955 and 1 cwt. per acre at the start of 1956 and 1957; and P2 with 4 cwt. per acre in 1955 only. It is interesting to note the very strong residual effect of phosphate in this treatment. In past years, the view was held that phosphate was rapidly fixed in the soil. This does not appear to be so on the soil here.

In August, 1956, the plots were split for gypsum which was applied at $1\frac{1}{2}$ cwt. per acre in order to supply additional sulphur to the soil. Gypsum was applied at the same rate again in April, 1957.

The effect of the treatments is broadly similar for all four grasses, and for convenience only the results for Rhodes grass and its associated legumes are given below in Table I.

TABLE I.—TOTAL DRY MATTER YIELD FOR THREE HARVESTS OF 1957, IN CWT. PER ACRE

	P0	P1	P2	Mean
Rhodes alone	7.27	11.94	11.84	10.35
Rhodes + Kenya white clover ..	18.42	28.49	17.13	21.35
Rhodes + clover + lucerne ..	25.09	36.51	40.57	34.06
Mean	16.93	25.65	23.18	

It is seen clearly that when legumes are growing vigorously in mixture with grasses, the total dry matter yield of the pastures can be substantially increased. Effective inoculation and adequate soil nutrients are necessary for strong legume growth and it is thought that the additional sulphur which was made available to the legumes in these plots has been responsible for their vigour.

(2) THE COMPARISON OF FOUR LEGUMES IN A GENERAL PURPOSE GRAZING LEY

In 1956, four legumes were sown in mixture with Nzoia Rhodes grass, with the object of comparing their yields, and of measuring their influence on the yield of the pasture. Triple superphosphate and gypsum had been applied basally at the rate of 1 cwt. and $1\frac{1}{2}$ cwt. per acre respectively at the start of the season.

The mean dry matter yield of Nzoia Rhodes grass with various legumes over two harvests in 1957 was as follows, and is given as cwt. of dry matter per acre: Nzoia Rhodes grass alone, 19.6, Nzoia Rhodes with Louisiana white clover, 26.3; with Kenya white clover 26.1; with Lucerne 25.4; and with Rueppells clover 21.2.

The results of this experiment also show that vigorously-growing legumes raise the total dry matter yield of a mixed grass-legume sward. When the grass and legumes were separated, the yields of the latter were as shown below, given again in cwt. of dry matter per acre for two harvests: Kenya white clover 10.4, Lucerne 9.2, Louisiana white clover 8.1, and Rueppells clover 5.4. The yields of Kenya clover, lucerne, and Louisiana clover differ significantly from that of Rueppells clover.

(3) A COMPARISON OF FIVE GENERAL PURPOSE LEY GRASSES UNDER GRAZING MANAGEMENT

In 1956, Rongai Rhodes, Molasses grass, Star grass (K.51424), Nandi *Setaria*, and Natal grass (*Beckeropsis unisetata*), were undersown in maize in single one-acre fields. The results of the grazings, as measured in cow-grazing days, are shown below in cow-grazing days per acre:—

Rongai Rhodes grass, 207; Molasses grass, 184; Star grass, 137; Natal or Beck grass, 108; and Nandi *Setaria*, 87.

The result for Nandi *Setaria* is disappointingly low because the establishment of the grass was not entirely satisfactory.

Running concurrently with the above, a clipping trial was started during the season, to obtain dry matter yield data for the same grasses and, in addition, two other grasses. These grasses are being compared in a randomized block experiment, and the yield results are given below on a leaf dry matter basis as cwt. per acre:—

Rongai Rhodes grass, 41.3; Molasses grass, 39.5; *Panicum coloratum* (Coloured Guinea grass), 37.0; *Panicum maximum* var. *tricholglume* (Slender Guinea), 31.8; *Beckeropsis unisetata*, 27.9; Nandi *Setaria*, 22.8, and Star grass, 22.6. Rongai Rhodes, Molasses grass, and Coloured Guinea grass have significantly more dry matter than all the other grasses during the first season.

Species Evaluation in Late Season Leys

(4) THE INFLUENCE OF LEGUMES ON THE YIELD OF A LATE SEASON LEY

During 1956, Slender Guinea grass was established both in pure stand and in separate mixtures with lucerne; *Glycine javanica* K.51112; perennial *Dolichos* sp. nr. *lablab*; and Rueppells clover (*Trifolium rueppellianum*). The grass and legumes were row planted in $2\frac{1}{2}$ ft. alternate lines in randomized blocks. The aim of the management imposed was to obtain the main bulk of grazing during the drier months from November to March. Triple superphosphate had been applied basally at the rate of $1\frac{1}{2}$ cwt. per acre during establishment. The mean yield of the grass together with the legume for the first season, 1956-57, was as shown below, and is given as dry matter yield in cwt. per acre:—

Slender Guinea grass alone, 46.1; Slender Guinea grass with *Dolichos* sp. nr. *lablab*, 43.5, with Rueppells clover 40.2, with lucerne 37.1, with *Glycine javanica* selection K.50101, 33.5, and with *Glycine javanica* selection K.51112, 31.7.

It is seen from the above that the presence of the legumes has depressed the total dry matter yield of the mixtures during their first season. This result is consistent with results obtained from other experiments on this station in which the legumes have either caused a depression, or have not significantly increased the dry matter yield during the year of establishment. It may be ascribed to:—

1. Lack of vigour in the legume due to a sulphur shortage in Kitale soil, with the result that nitrogen fixation by the legumes was probably inefficient.

2. Competition between the grass and the legume for moisture during periods of relative dryness. More work needs to be done to resolve the underlying reason for the depression.

Ley Management

(1) THE MANAGEMENT OF GENERAL PURPOSE GRAZING LEYS

In 1955, Nzoia Rhodes grass, Molasses grass, Slender Guinea grass, and Nandi *Setaria* were each sown in mixture with Kenya white clover and lucerne in separate plots. The results of the grazings for three years are given below in Table 2.

TABLE 2—THE EFFECT OF MANAGEMENT ON STOCK CARRYING CAPACITY

MANAGEMENT	YEAR		
	1955 Cow grazing days/acre	1956 Cow grazing days/acre	1957 Cow grazing days/acre
(a) Grazing tall herbage without mowing ..	264	248	278
(b) Frequent grazing at a young stage, with residues mown	186	181	207
(c) Infrequent grazings, with residues mown ..	156	173	232
(d) Cutting the first flush for hay, followed by grazing as in (a)	170 + Hay	180 + Hay	155 + Hay

Treatment (a) continues to carry the highest number of stock; Treatment (b), while carrying less stock, appears to have been of higher quality because of the prevalence of the associated clover.

This experiment has made it clear that the balance of grass and Kenya white clover can be controlled to a large extent by means of management. Treatment (a) favoured the grasses and suppressed the clover. Treatment (b) suppressed the grasses and encouraged clover dominance. Treatment (c) encouraged the lucerne.

Of the four grasses, Nandi *Setaria* has withstood the close grazing and mowing treatment better than the others, and shows itself to be a satisfactory species under the management which was imposed by treatment (b).

(2) THE EFFECT OF MANAGEMENT ON NANDI SETARIA

The results of an observation trial comparing legume nitrogen with sulphate of ammonia, and heavy and light grazing on the production of Nandi *Setaria* are presented in Table 3 below.

Treatments—

1. Nandi *Setaria* with *Trifolium rueppellianum*, heavily grazed.
2. Nandi *Setaria* with sulphate of ammonia at 2 cwt./acre, heavily grazed.
3. Nandi *Setaria* with *Trifolium rueppellianum*, lightly grazed.
4. Nandi *Setaria* with sulphate of ammonia at 2 cwt./acre, lightly grazed.

TABLE 3—YIELD OF DRY MATTER FROM THE GRASS ALONE
(lb. per acre)

TREATMENT	1	2	3	4	Mean	S.E.
Yield	2155	2171	3243	2068	2409	227

From Table 3 it can be seen that the yield resulting from treatment 3, i.e. Nandi *Setaria* with the legume lightly grazed, is significantly higher than those from the other treatments (at the 1 per cent level). This suggests that the presence of the legume has had a very strong effect on the production of the grass, compared with the effect of 2 cwt. of sulphate of ammonia. Management alone has had little or no apparent effect on the yield of the grass, but has favoured the growth of the clover in the light-grazing treatment.

The Effect of Fertilizers and Manures

The six experiments outlined here are concerned mainly with the effect of phosphate and gypsum applications, and are concerned with testing the amounts of phosphate required by lucerne, the best form in which to apply it, and with combinations of gypsum and phosphate. One experiment shows well the beneficial effect of gypsum on grass, clover and lucerne mixtures, and it is a good step towards efficient fertility building by pasture legumes. One experiment to test the effect of boron and magnesium on lucerne has given inconclusive results.

(1) THE EFFECT OF CALCIUM, SULPHUR AND GYPSUM ON THE GROWTH OF LUCERNE

A randomized block experiment in six replications compared the application of calcium carbonate alone, elemental sulphur alone, and these two treatments combined, as against an application of $1\frac{1}{2}$ cwt. of gypsum per acre on the production of lucerne. The amount of calcium and sulphur applied was equivalent to that contained in $1\frac{1}{2}$ cwt. of gypsum. Two cuts have been taken this year and the combined results are shown in Table 5.

TABLE 5—YIELDS OF DRY MATTER
(lb. per acre)

TREATMENTS	Lime (1)	Sulphur (2)	Gypsum (3)	Control (4)	1 and 2 combined (5)	Sulphur 8 lb./acre (6)	Mean	S.E.
Yield ..	2423	2591	2683	2161	3295	2589	2624	229

These results show that the yield of treatment 5, calcium and sulphur, and treatment 3, gypsum, are significantly better than control (at the 1 per cent and 5 per cent levels of significance respectively). No other treatments significantly outyielded control. This result indicates that calcium and sulphur are both required by the lucerne. The response to gypsum may well be lower than anticipated because the land has previously grown three maize crops, and each of these received just under $\frac{1}{2}$ cwt. per acre of sulphate of ammonia. The stover from the last maize crop was also ploughed in. There may thus have been a slight residual effect of the sulphur from the ammonium sulphate and probably also from the ploughed-in stover. Another point of interest is that the gypsum is probably more slowly available to the lucerne than the mixture of lime and sulphur, which latter has so far given the biggest response.

(2) THE RESPONSE OF LUCERNE TO DIFFERENT FORMS OF PHOSPHATE

In a randomized block experiment with four replications, the following five forms of phosphate, in the presence and absence of gypsum, were compared on the production of lucerne: triple superphosphate, single superphosphate, basic slag, local soda phosphate and Uganda rock phosphate. The combined results of two cuts are summarized in Table 6.

TABLE 6—SUMMARY OF YIELDS
(lb. per acre of dry matter)

	Triple Supers	Single Supers	Basic Slag	Soda Phosph.	Rock Phosph.	Control	Mean	S.E.
With gypsum	2559	2427	2750	2698	1861	2128	2389	265
No gypsum	2066	2342	2880	2572	2003			

The results show that the yields resulting from the soda phosphate with gypsum treatment and from the basic slag with gypsum treatment, are significantly higher than the control yield (at the 5 per cent level) and that the treatment with basic slag alone is significantly higher than that of the control (at the 1 per cent level).

Several experiments were carried out with leguminous plants to test the effect of phosphate and gypsum, singly and together, and also the effect of magnesium and boron in addition. The results are given below.

(3) RESPONSE OF *Trifolium rueppellianum* TO SUPERS AND GYPSUM

TABLE 7—SUMMARY OF YIELDS

	Supers and Gypsum	Supers	Gypsum	Control	S.E.
Dry matter (cwt./acre) .. .	37.4	34.6	20.2	17.1	1.87
Crude Protein (cwt./acre) ..	6.6	6.3	3.5	2.9	
Phosphorus (lb./acre) ..	5.75	5.0	3.37	3.0	

Supers alone, and supers plus gypsum, gave a significantly higher yield than gypsum alone or the control.

(4) RESPONSE OF YARLOOP SUBTERRANEAN CLOVER TO SUPERS AND GYPSUM

TABLE 8—SUMMARY OF YIELDS

	Supers and Gypsum	Supers	Gypsum	Control
Dry matter (cwt./acre)	47.8	42.2	42.62	29.41
Crude protein (cwt./acre) ..	6.5	5.6	5.9	3.9
Phosphorus (lb./acre)	8.5	8.4	7.0	4.8

The yield differences were not significant. The figures nevertheless seem to indicate that a beneficial effect is obtained from both supers and gypsum, and more so from these two combined together.

(5) THE EFFECT OF SUPERS, GYPSUM, MAGNESIUM AND BORON ON LUCERNE

In an experiment on lucerne, which was treated with various combinations of superphosphate, gypsum, magnesium and boron, the mean plot yields as lbs. of dry matter from the two cuts obtained are as follows: control, 11.5; supers alone, 10.6; gypsum alone, 11.38; supers plus gypsum, 13.15; supers plus gypsum plus magnesium, 14.55; and supers plus gypsum plus magnesium plus boron, 13.86 lb. The low and non-existent responses to gypsum and supers respectively are probably due to the manuring of the three previous maize crops again, which received 1 cwt. supers and $\frac{1}{2}$ cwt. of ammonium sulphate annually, and also perhaps to the stover of the last maize crop which was ploughed in. The impression obtained from this experiment was that the lucerne was not growing as well as one would expect, and the response to treatments was poor all round. This may possibly be due to some mineral deficiency in the soil which needs to be corrected.

(6) THE EFFECTS OF GYPSUM ON GRASS, CLOVER AND LUCERNE

There is an increasing volume of evidence to show that legumes are capable of fixing nitrogen under conditions at Kitale provided that inoculation is satisfactory, and mineral shortages in the soil have been sufficiently adjusted. In this respect the beneficial influence of gypsum, presumably because of the additional sulphur it supplies to the legumes, continues to show up clearly in experiments using grass-legume mixtures.

The results shown in Table 9 are recorded from the experiment described at (1) under the heading *Species Evaluation of General Purpose Leys*. In this experiment the plots were split for the application of gypsum at $1\frac{1}{2}$ cwt. per acre in August, 1956, and again in April, 1957:—

TABLE 9—MEAN DRY MATTER YIELD FOR THREE HARVESTS OF 1957
(cwt. per acre)

TREATMENT	Control	Gypsum
Rhodes grass alone	8.2	10.4
Rhodes plus Kenya white clover	8.1	21.4
Rhodes plus clover and lucerne	9.3	34.1

Gypsum has caused a substantial increase in the dry matter yields of the mixed grass-legume plots.

The nitrogen content of legumes may be affected by application of gypsum. The mean nitrogen content of Kenya white clover for the first harvest in 1957, as a percentage of dry matter, was 2.35 per cent in the control and, with gypsum, 3.15 per cent. Similarly, the sulphur content of Kenya white clover is also affected by application of gypsum. The S content, expressed as a percentage of the dry matter, was 0.114 in the controls and 0.195 per cent in the gypsum plots.

In an experiment on lucerne, the following mean yields of dry matter were recorded from seven cuts following the application of gypsum; control plots 31.9 cwt. per acre of dry matter, gypsum plots 44.3 cwt. Here, also, the gypsum was applied at the rate of $1\frac{1}{2}$ cwt. per acre in August, 1956, and at the same rate again in April, 1957.

The general conclusions to be drawn from these experiments (some of which are still unfinished) seem to be as follows:—

- (a) smaller dressings of phosphates than used hitherto may be adequate, in view of the strong residual effects which appear to exist;
- (b) the beneficial effect of gypsum on clover and lucerne has received further confirmation;
- (c) basic slag has shown up well as a phosphatic fertilizer with lucerne in the first year. More work will be necessary to see if this is confirmed in other areas and on different soil types;
- (d) the increase in the yield of grass obtainable by the inclusion of Kenya white clover and lucerne in the ley mixture is beginning to show up;
- (e) experiments with trace elements have been inconclusive, but it is believed that the rates and combinations applied were not right, in view of deficiency symptoms which can be observed on clovers and lucerne.

Animal Agronomy

In this second year of the animal agronomy work, it has been possible to begin large-scale field experiments with the object of evaluating pastures by measuring the live-weight increase of beef animals. A preliminary report of the results of one of these experiments is given below.

*The Evaluation of the productivity of a Rhodes Grass-Trifolium
Semipilosum Ley*

In this experiment a mixture of Rhodes grass and *Trifolium semipilosum* was established with triple superphosphate applied to the seed-bed at 80 lb. per acre and gypsum at 1½ cwt. per acre. This same seeds mixture was also established with a "control" dressing of triple superphosphate only, applied at 30 lb. per acre. Four weeks after establishment, the more heavily fertilized plots received a dressing of 80 lb. per acre of sulphate of ammonia. The results of grazing from September to November are given below:—

TABLE 10—RESULTS OF THE SEPTEMBER-NOVEMBER GRAZING

TREATMENT	Grazing period (days)	Total live- weight gain (per head)	MEAN LIVELWEIGHT GAIN	
			(daily)	(lb. per acre)
Phosphate and gypsum and Sulphate of ammonia ..	63	66	1.03	135
Control	63	48	0.75	49

It is clear from these results that over the nine weeks period, the control treatment has so far produced less satisfactory live-weight gains.

Co-operative Experiments

The co-operative experiments programme, which is designed to check the Station's experimental results on other soil types in the vicinity, and under different rainfall, has been concerned with finding where else responses to gypsum by legumes occur, and also the best pasture legume for various conditions. Gypsum responses have been found on central Cherangani farms and on farms in a line from there through the Hoey's Bridge to the Lugari district, and in one instance on Mt. Elgon near the Suam River.

No responses have been obtained from the soils of Endebess, Soy, Eldoret or Ainabkoi. Subterranean clover has grown well on soils cleared from forest in the Cherangani Hills.

Report of the Pasture Research Chemist

THE "ACID-FIBRE" DETERMINATION

Further aspects to the use of an acid digestion for "fibre" determination have been studied this year, viz.:—

- (i) The effect of removing fats from the materials, on the subsequent determination;
- (ii) the use of 5 per cent hydrochloric acid as against 1.5 normal sulphuric acid as the solvent during a digestion period of 1½ hours duration;
- (iii) the nitrogen content of the acid-fibre residue; and
- (iv) the relationship between conventional "crude fibre" and "acid-fibre".

Using a boiling alcohol-benzene mixture, it was found that the amount of fats extracted from the materials used increased with increasing time of extraction; an eight-hour extraction period was decided upon as the minimum time to be allowed for the operation. The removal of fats in this way causes a reduction in the amount of acid-fibre remaining after digestion either with 5 per cent hydrochloric acid or with 1.5 normal sulphuric acid. Furthermore, the residue obtained by digestion with the former acid is less than that obtained by digestion with the latter and the crude protein ($N \times 6.25$) contaminating the fibre-residue is less after the hydrochloric acid digestion than it is after the sulphuric acid digestion. It is clear that if fibre is to be determined by acid digestion only, it will be necessary to carry out the determination on material that is freed from fats, and to correct for the crude protein contained in the acid-fibre residue.

It is apparent that there is a relationship between "crude fibre" determined by a conventional procedure (Fertilizers and Feeding Stuffs Regulations, 1952) and "acid-fibre" determined by digesting fat-free material for $1\frac{1}{2}$ hours with 1.5 normal sulphuric acid and deducting the crude protein contained in the fibre residue. The following equation expresses this relationship:—

$$1.5 \text{ normal H}_2\text{SO}_4 \text{ fibre} = 1.265 \text{ crude fibre} = 0.34.$$

THE WEDEMAYER DIGESTION

It was reported last year that the digestible crude protein (dig.P) contained in the dry matter of Kenya feeding stuffs is related directly to their crude protein (c.p) content and that the equation

$$\text{dig.P} = 0.94 \text{ c.p.} - 2.51 \quad (\text{i})$$

expresses this relationship. Since then the effect of crude fibre (c.f.) on the digestibility of the crude protein contained in the same feeds has been studied by taking the former fraction into account in a multiple regression. The new equation is:

$$\text{dig.P} = 0.96 \text{ c.p.} + 0.02 \text{ c.f.} - 3.16 \quad (\text{ii})$$

These two equations are not statistically different and so, in fact, estimates of protein digestibility based on Wedemeyer's technique are not improved by taking crude fibre into account. Crude fibre apparently is not important in artificial digestions, but it is well known that it is very important in animal digestibility experiments. Glover and French (*J. Agric. Sci.*, 1957) have recently made a synthesis of world data appertaining to animal digestibility experiments and by means of an equation they show how the digestible crude protein contained in a feeding stuff is connected with its crude protein and its crude fibre content. Their equation may be written in the form:

$$\text{dig.P} = \text{c.p.} (5 + 60 \log. \text{c.p.} - 0.33 \text{ c.f.}) \div 100 \quad (\text{iii})$$

When equations (i) and (iii) are tested by using both to estimate the results of recorded digestibility trials, it is found that the Wedemeyer (i) equation gives results which are almost consistently much too high, whereas the Glover and French equation gives results which are in much closer agreement with the values actually recorded.

Estimates of the digestible crude protein contained in feeding stuffs may therefore be determined more satisfactorily from the Glover and French equation than from the Wedemeyer equation.

FODDER TREES AND SHRUBS, LEGUMES AND GRASSES

In collaboration with Mr. J. Glover, Plant Physiologist, E.A.A.F.R.O., studies on the chemical composition of fodder trees and shrubs, legumes, and grasses at a specific stage in their maturity, have continued. A detailed study of four ley species, namely Rhodes, Molasses, Star and *Setaria* and one grass of "natural" grassland, viz. *Hyparrhenia dissoluta*, all of which are grown on this Station, began in February. The proximate constituents of these grasses together with their calcium and phosphorus content are being determined at one-week intervals in order to make an accurate assessment of the variation in their chemical composition at different stages of maturity. The effect of rainfall on chemical composition is part of this study. A similar study is in progress with two grasses of "natural grassland", viz. *Themeda triandra* and *Pennisetum stramineum*, of the Laikipia plateau. These two grasses are sampled at two-weeks' intervals.

Of the many relationships examined, the most striking is that which occurs between total carbohydrate, that is "soluble" carbohydrate together with "crude fibre", and crude protein. No significant differences were found between the individual equations which connect the "total carbohydrate" with the crude protein in fodder trees and shrubs; in legumes; in grasses at a specific stage of growth and in ley grasses. The general equation arrived at to express the "total carbohydrate"/crude protein relationship for these materials is

$$\text{"total carbohydrate"} = 89 - 1.1 \text{ crude protein.}$$

No relationship between these two variables has been found for *Themeda triandra* but for *Hyparrhenia dissoluta* (Kitale) and for *Pennisetum stramineum* (Laikipia) respectively there are relationships which do not differ significantly. The data for these latter two grasses were pooled to give the equation:

$$\text{"total carbohydrate"} = 90.2 - 1.6 \text{ crude protein.}$$

THE PHOSPHORUS REQUIREMENTS OF GRAZED STAR GRASS PASTURE

Two field experiments, one on the E.A.A.F.R.O. farm, Muguga, and one on the Station farm, Kitale, were established in 1956, in order to study the phosphate requirements of grazed Star grass pasture. In these experiments, the treatments are as follows:—

A.—No phosphate.

B.—Triple superphosphates were applied in 1957 for the first time at 30 lb. P_2O_5 per acre. This dressing will be repeated in 1959.

C.—Triple superphosphates were applied in 1957 for the first time at 60 lb. P_2O_5 per acre.

D.—Triple superphosphates were applied in 1956 for establishment at 30 lb. P_2O_5 per acre. This dressing will be repeated in 1958.

E.—Triple superphosphates were applied in 1956 for establishment at 60 lb. P_2O_5 per acre.

F.—No phosphate.

Plots A, B, C, D, and E received 50 lb. Urea (= 25 lb. nitrogen) per acre for establishment and the same amount is applied after each grazing. There are four replications of these treatments in the E.A.A.F.R.O. experiment and three in the Kitale experiment. The plot size is one-sixth acre and the area harvested for yield data and for herbage composition is 30 sq. yd. per plot, the area consisting of three randomized strips each 5 yd. $\times$ 2 yd.

The mean results of the two experiments, in terms of dry matter yields, and the percentage phosphorus contained in the herbage are given below for each of the two harvests obtained during the present year:—

YIELD OF DRY MATTER

(cwt. per acre)

E.A.A.F.R.O. STAR GRASS

1957	TREATMENT						Standard Error
	A	B	C	D	E	F	
1st harvest 10-6-57 ..	33.0	35.2	45.8	40.4	44.7	25.0	3.6**
2nd harvest 21-10-57 ..	12.6	9.0	10.3	12.5	13.8	4.8	2.1 (N.S.)

P. CONTENT OF THE DRY MATTER—PER CENT

E.A.A.F.R.O. STAR GRASS

1957	TREATMENT						Standard Error
	A	B	C	D	E	F	
1st harvest	0.169	0.223	0.255	0.178	0.194	0.156	0.014**
2nd harvest	0.070	0.073	0.073	0.068	0.075	0.056	0.007 (N.S.)

YIELD OF DRY MATTER

(cwt. per acre)

KITALE STAR GRASS

1957	TREATMENT						Standard Error
	A	B	C	D	E	F	
1st harvest 24-6-57 ..	8.3	17.5	22.8	11.9	12.7	10.5	2.08**
2nd harvest 23-9-57 ..	8.8	13.7	14.8	13.0	16.4	11.5	1.91 (N.S.)

P. CONTENT OF THE DRY MATTER—PER CENT

KITALE STAR GRASS

1957	TREATMENT						Standard Error
	A	B	C	D	E	F	
1st harvest	0.266	0.233	0.266	0.287	0.277	0.257	0.026 (N.S.)
2nd harvest	0.277	0.236	0.300	0.280	0.296	0.233	0.028 (N.S.)

In the first harvest of the E.A.A.F.R.O. experiment, yields of dry matter from C, D and E treatments were significantly higher than those from the remaining treatments. The F = control treatment gave the lowest yield. Yields of dry matter from the second harvest showed no significant treatment differences though the F treatment again gave the lowest yield. The phosphorus content of the herbage obtained from B and C treatments was significantly higher than that obtained from the remaining treatment in the first harvest. No significant treatment differences were observed in the second harvest but the herbage from the F treatment contained less phosphorus than the remainder.

In the first harvest of the Kitale experiment, yields of dry matter from B and C treatments were significantly higher than those from the remaining treatments which did not differ significantly from each other. Yields of dry matter from the second harvest showed no significant treatment differences. The phosphorus content of the herbage showed no significant differences due to treatment in either the first or the second harvest.

Molo Grassland Research Sub-station

Experiments during the season were somewhat set back by the abnormally dry September and October. Particular attention is being given to the effect of nitrogen on leys, whether as fertilizer nitrogen or from legumes; the former, largely to find out what the potential production can be from leys, the latter as a problem demanding early solution and inclusion into farming practice. Results from fertilizer nitrogen leave no doubt that the potential production from leys at high altitudes is very substantial, for example 32 tons (fresh weight) was produced by Westerwolths ryegrass over a two-year period, with regular top dressings compared with about six tons without nitrogen. It is likely (on the basis of a single season's work) that urea as a top dressing will be about 15 per cent less effective than the same amount of nitrogen applied as sulphate of ammonia or nitro-chalk; there were no differences in response between the two latter fertilizers. With ewes and their lambs, a preliminary trial showed that over a 2½-month period of rotational grazing, perennial ryegrass produced 164, 201 and 243 lb. live-weight increase an acre of lambs for respective dressings of 0, 2 and 5 cwt./acre of nitro-chalk. This trial will be repeated next season with weaned lambs, when much larger live-weight increases are expected.

For mixed leys, excellent mixtures of subterranean clover and perennial ryegrass have been established under differential managements, to see if overgrazing is largely responsible for the common failure of the subterranean clovers to volunteer in the subsequent season. Kenya white clover (*Trifolium semipilosum*) showed promise in mixtures under grazing early in the season, but at the time of writing is not so vigorous. It is likely that selections from this clover, and from *T. burchellianum* var. *johnstonii* will have to be made to find suitable strains for the higher altitudes. Work on this will start next year. Serradella, amongst the annual legumes, can be strongly recommended as a most vigorous grower which nodulates well whilst being easier and less wasteful for sheep to graze than lupins.

Of the new grass strains reported last year, Westerwolths ryegrass will definitely persist for two years provided that the fertility is high, whilst "Bromar" brome grass will also persist well for the two seasons. "Oat grass" (*Arrhenatherum elatior*) is showing promise, and S170 tall fescue may well replace K31 fescue. Other work on fertilizers, minor elements, selection of seeding strains of ryegrasses and cocksfoots, and grazing management trials continue but are not advanced enough for reporting yet.

Report of the Pasture Research Officer, Katumani

MAKAVETE

The Makavete experiment on the reseedling of overgrazed and denuded land was ended in November, and although the complete results have not yet been worked out, some interesting facts have emerged. A mixture of *Cenchrus ciliaris* and *Eragrostis superba* has proved to be outstandingly successful both in persistence and productivity. By conserving some grass as hay during the dry season, a stocking rate of one beast to two acres was maintained satisfactorily between November, 1956, and November, 1957. Fertilizer was shown to have a big effect in increasing the persistence of Rhodes grass and Star grass. An annual broadcast dressing of double supers, ammonium sulphate, and muriate of potash each at 1 cwt. per acre was required. The following percentage increases were obtained:—

Star grass, 44; Rhodes grass 41; Makarikari, 25; *Cenchrus*, 21, and natural grassland, 11 per cent.

PLANT INTRODUCTIONS

The most promising grasses for use in this area appear to be Rhodes grass, *Cenchrus ciliaris*, *Cenchrus setigerus*, *Eragrostis superba*, *Bothriochloa insculpta*, *Panicum maximum* and Star grass. The most leafy, persistent and productive strains are being sought and tested under grazing. Other grasses which are particularly valuable for dry season grazing are Elephant grass, Columbus grass and Sudan grass. The only legumes which seem to be promising are *Clitoria ternatea* and *Indigofera subulata*. Both legumes nodulate well; the former is very drought-resistant, and both are palatable.

Report of the Pasture Research Officer, Kamasia Reserve

SURVEY WORK

The area served by the Kamasia Pasture Research Station comprises Baringo, Samburu, West Suk and lower Kigeyo-Marakwet.

During the year, ecological surveys have been conducted throughout these semi-arid areas. On a District level, extensive surveys have been conducted, aimed at producing an accurate, medium-scale map for each District. On an extensive scale, surveys on the ecology and present land condition of areas of particular interest are undertaken; to date, these have been done only on request, to provide a basis to the introduction of agricultural schemes.

Much of the information gathered on the extensive surveys has not yet been aggregated into map form but, to date, five areas (four in Baringo, and one in Samburu) have been covered intensively, and maps and reports have been prepared, or are in the process of preparation. The following reports were issued during the year:—

“Land Condition and Potential within the Perkerra Catchment Area” (with three maps). January, 1957.

“Land Condition and Potential within the Smallholding Areas of the Perkerra Catchment Area” (with two maps). April, 1957.

“Report of a Brief Ecological Survey of Churo B.2 Area” (with map). April, 1957.

“Report of a Brief Ecological Survey of Ngalesha B.I. Area (with map). April, 1957.

EXPERIMENTAL WORK

Present experiments may be grouped as follows:—

Experiments on Natural Grassland

(A) The restoration of a grass cover to denuded area:—

(a) Reseeding denuded land in Baringo.

(b) Work on and within grazing schemes.

The recording of botanical changes within the South Baringo Grazing Scheme.

(B) Bush Control:—

(a) The control of bush at Esageri by fire, goats and preliminary thinning (in preparation).

(b) The effect of time of burning on bush control at Riwa Grazing Scheme (in preparation).

Experiments on Irrigated Pastures

(a) The irrigated nursery.

(b) The selection of grasses and legumes suitable for growth under irrigation at Marigat.

Where it is both possible and permissible, experiments are sited within established agricultural schemes, under controlled conditions, where the forces of the environment, particularly as exemplified by the Tugen and his stock, cannot exert the same undesirable influence on the experimental error, as they can, without control, in the Reserve!

In order that this control may be obtained in future experiments for which Reserve conditions are not necessary, but which cannot be fitted into the framework of any agricultural scheme, a 200-acre experimental area has been acquired at Chemogoch, in the Acacia-Themedza Zone of Baringo. This area has been perimeter fenced, to allow for the recovery of the grass cover prior to experimentation.

Experimental results that have been obtained to date are detailed below.

NATURAL GRASSLAND

Reseeding Denuded Land in Baringo

At three sites in Baringo, the following treatments were compared on $\frac{1}{4}$ -acre plots (with two replicates), using a seeds mixture containing 14 grasses, broadcast at a rate of 11 lb. per acre:—

Seed Treatment

Pelleted seed (P) (seed held in a
pellet of soil and *boma* manure) ×
Unpelleted seed (U)
No seed (C)

Soil Treatment

Scratch ploughing (*jembe*) (S)
Branches placed on surface (B)
Soil untouched and unprotected (O)

The control plots (CS, CB, CO) were split, one-half of each being planted with roots of Star grass (*Cynodon dactylon*).

The three sites are as follows:—

Sabur (4,100 ft.)—White, erodeable subsoil and basement complex, with no topsoil. Sown 30th April, 1957.

Ngambo (3,200 ft.)—Alluvial silt, with only slight erosion. Sown 14th May, 1957.

Radat (4,100 ft.)—Typical red loam with rock outcrops. Sown 23rd May, 1957.

The final results will not be available until the end of the 1958 season, but the position at the end of the 1957 season is given below, in terms of the numbers of sown and established grass plants in a 80 sq. ft. sample area. Volunteer species are not included.

		SABUR				NGAMBO				RADAT			
		S	B	O	Total	S	B	O	Total	S	B	O	Totals
P	.. ..	100	70	39	209	10	—	—	10	8	2	6	16
U	.. ..	76	50	41	167	2	1	—	3	31	2	—	33
C	.. ..	10	7	—	17	—	1	—	1	4	1	1	6
Total	..	186	127	80	393	12	2	—	14	43	5	7	55

These results which exhibit statistically significant trends should be considered in the light of the following rainfall figures:—

	*June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
Sabur	4.00	2.73	5.13	0.40	1.20	1.86	0.35
Ngambo	1.78	0.54	3.69	0.20	1.54	1.50	0.72
Radat	2.13	1.78	3.50	0.40	1.36	0.79	2.10

* Recording started in June; records incomplete for this month.

The following should be noted:—

(1) It was impossible to lay down the experiment before the onset of the rains which started in mid-April.

(2) The greatest success was obtained at Sabur, despite the fact that this site was by far the most badly eroded. The answer is believed to lie in the higher rainfall of this area: the site with the lowest rainfall (Ngambo) was also the least successful.

(3) The necessity for scratch ploughing was shown at all sites. Branches on the surface of the soil are advantageous, but their effect, unless placed very thickly, is less marked.

(4) Beneficial effects were obtained from pelleting at Sabur and Ngambo, but not at Radat, where both the hardcapped soil and the rock outcrops were active in preventing the young seedlings from getting a foothold. There are, therefore, unexpected advantages to be had from reseeding on a highly erodeable soil.

With regard to the Star grass roots planted in the control plots, the position may be summarized by reference to the percentage mortality, as recorded at the end of the season:—

	<i>Per cent</i>
Sabur	3.2
Ngambo	95.5
Radat	20.9

No consistent plot differences were recorded.

The Recording of Botanical Changes within the South Baringo Grazing Scheme

The first step in this project was taken in September, 1956, when four line transects were laid down in selected areas of denudation in Block IV of the scheme. Two of these transects (Nos. I and II) represent an area in the very first stage of recolonization, the other two (Nos. III and IV) representing a higher stage in the succession. The following table indicates the state in which these areas entered the 1957 season:—

SPECIES	TRANSECTS			
	I	II	III	IV
<i>Aristida mutabilis</i> ..	0.6	1.0	6.8	—
* <i>Eragrostis</i> spp. ..	0.3	0.5	—	6.7
<i>Tetrapogon spathaceus</i> ..	0.3	0.4	0.2	1.1
<i>Chloris pycnothrix</i> ..	0.8	—	—	—
<i>Cynodon dactylon</i> ..	—	—	0.6	—
<i>Digitaria divinatorum</i> ..	—	0.5	—	—
<i>Chloris virgata</i> ..	0.4	—	—	—
Others	0.4	0.5	—	0.2
Basal Cover (%) ..	2.8	2.9	7.6	8.0

*Mainly *E. cilianensis* and *E. pilosa*.

IRRIGATED PASTURE

The Irrigated Nursery

Although the dry land nursery is still awaiting a suitable permanent site, it was possible to establish the irrigated nursery in November, 1957. To date, several small samples of grass and legume seed, the latter mainly obtained from Southern Rhodesia, have been planted. Of these, *Vigna parviflora* and *Crotalaria intermedia* have been promising in their early growth.

The Selection of Grasses and Legumes Suitable for Growth under Irrigation at Marigat

At present, there are 12 grasses and seven legumes included in this trial. The trial is still in too early a stage to draw any reliable conclusions.

Report of the Pasture Research Officer, Ranching Areas

A survey of the ranching areas of the Kenya Highlands is being carried out to determine systems of management and pasture problems. This has taken up the greater part of the year. Thirty-six visits to the Laikipia and Mount Kenya areas were made; 14 to the Rift Valley area and five to the Machakos area, i.e. 55 properties in all, were visited.

Notes have been made on the management, the stocking, and the production from each of these properties. The results can be summarized as follows:—

The general standard of development and of management can be improved. Severe overgrazing is present only in a few isolated instances, but there are large areas overgrazed. Bush presents the largest single problem. The survey is nearing completion. Overall figures are being obtained and ecological maps of the areas are being prepared. An excellent picture of conditions of management in the ranching areas is being obtained.

A bush control trial involving spraying with 2,4,5.T and cutting is being carried out on a marginal farm with mixed bush, in co-operation with the A.O. Experiments, Ol Joro Orok. In conjunction with the Pasture Research Chemist, the chemistry of *Pennisetum stramineum* and of *Themeda triandra* are being studied.

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E. D. BUMPUS,
Senior Pasture Research Officer.

ANNUAL REPORT OF THE SENIOR HORTICULTURAL OFFICER, 1957

Review of the Year

A crisis occurred in pineapple canning when the largest cannery stopped buying for a short period. This was due largely to increased foreign competition on the United Kingdom market and to expanding production of canned pineapple in several Commonwealth countries. A meeting of Commonwealth producers in London resulted in a measure of agreement being reached on future co-operation. The indications are that Kenya canned pineapple will maintain its place on the market, provided every effort is made by growers and canners to lower costs of production, and to improve quality.

Fresh pineapple exports by air were continued successfully, but a consignment sent by sea was unsaleable owing to the ship being diverted, and the voyage thus being considerably longer than was expected. A new development was the export to London by air of mangoes from Malindi. The fruit was very favourably received, and prices realized gave a much better return to growers than they obtain from fruit marketed locally.

A considerable acreage of tomatoes, for the manufacture of tomato purée, was planted at the Perkerra Irrigation Scheme, and by farmers in the Nakuru, Naivasha and Trans Nzoia districts. Yields were not so high as was anticipated by some people but, in the opinion of the writer, were as high as could be reasonably expected. Considerable local experience is needed to produce the best results with canning tomatoes, and as this is a new crop in Kenya, there are bound to be difficulties in the first seasons. When it is considered that the average yield of canning tomatoes in the United States, for the period 1940-1949 was only 5.89 tons per acre, the yield of just under 4 tons per acre from the block of 100 acres at Perkerra does not appear unduly low. Development of canning tomatoes is likely to follow the pattern of pineapples, the yield of which since 1951 has been enormously increased by improved cultural methods.

The introduction of fresh frozen fruit and vegetables from England on to the local market, has caused some alarm amongst producers. It is considered, however, that the local product will compete successfully, provided it is of a high standard and attractively presented in consumer-size packages.

The formation of the Kenya Citrus Growers' Association by producers in East Nyanza is a welcome development. The Association has set high standards for its products which, when they become better known on the market, should do much to change the current preference for imported oranges.

The Horticultural Research Station, Thika.—Considerable development of this new station has taken place. The main part of the investigational programme is on pineapples, but trials have also been started with a wide range of other horticultural crops which are suited to this climatic zone.

Pineapples.—Further trials with and without fertilizers on vleis and black cotton soils, have confirmed previous results, that good yields of pineapples can be obtained provided these soils are properly drained. On black cotton soil, sulphate of ammonia at one ton per acre, and farmyard manure at 20 tons per acre gave a slight increase in yield, but this was insufficient to pay for the

fertilizer and manure. In this trial, the nil treatment yielded at the rate of 20 tons per acre. Trials with herbicides, to control couch in pineapple crops have met with some success. Dowpon has given satisfactory control in areas heavily infested with couch, when used at 7-15 lb. per acre, though the optimum amount has still to be worked out. Retreatment becomes necessary after 9-12 months.

Tree Crops.—Comparison of yields from irrigated and unirrigated citrus trees planted 1950-1952, at Jacaranda and Kitale sub-stations is beginning to give interesting results. At Jacaranda there has been a much more favourable response to irrigation than in previous seasons. At Kitale some orange varieties have yielded three times the crop when grown under irrigation, and the crop is harvested over a comparatively short period. Unirrigated trees tend to bear in a more irregular manner, the crop resulting from several small flowerings rather than one big one. An experimental consignment of Fuerte avocados from Kitale, sent to England by air, received favourable comment in Covent Garden. However, the price realized was insufficient to pay for the cost of freight and handling.

At Molo, 390 hours of sunlight were recorded during the winter months of July-August, compared to 250-300 hours, which is the average for a normal season. As a result, deciduous fruit trees have not received adequate chilling, and symptoms of prolonged dormancy have been more in evidence than in any other season during the past ten years. The main plum crop was two to three weeks earlier than usual; the apple crop is light and is being adversely affected by lack of leaves on the trees.

Berry Fruits.—The system of strawberry cultivation evolved at Molo, has now been given a thorough trial; it enables the production of heavy crops, at high altitudes, on or near the equator, at any time of the year, except during periods of heavy rain. At lower altitudes, where strawberries are not always in the flowering phase, some modification of the system will be necessary. Mass selection of seedling strawberries, with the object of producing strain suited to local climatic conditions, is now in progress.

Asparagus.—The first year's results of the Season of Cutting trial at Molo, show the heaviest yield during the period December to March, when soil temperatures are highest. A similar trial at Kakamega yielded best in September-October. These trials will have to be continued over a period of years before reliable results can be obtained.

Tomatoes.—A number of trials in connexion with the production of canning tomatoes have been carried out at the Mwea/Tebere, and Perkerra Irrigation Schemes. The most important result was from the Spacing and Staking trial at Perkerra, with the variety San Marzano. The mean yield from the stakes treatment was 17,581 lb. per acre, which was lower than the yield from any of the unstaked treatments. The highest yield was from the unstaked double row spacing, $5\frac{1}{2}$ ft. $\times$ $3\frac{1}{2}$ ft. $\times$ 2 ft, which was at the rate of 26,548 lb. per acre. There has been considerable controversy over the staking of canning tomatoes, which is an expensive operation; this result proves that our policy of not staking is correct.

Cucumbers and Melons.—Trials carried out at Perkerra and Rongai proved that certain varieties can be produced successfully, whilst others are quite unsuitable for local conditions. Efficient control of melon fly was obtained with a Malathion bait.

Tree Fruits

PROLONGED DORMANCY OF DECIDUOUS FRUITS

The winter season of 1957 (July-August), was exceptionally mild. Mean screen temperature for the two months was little higher than usual, being 54.9° F., but hours of sunlight recorded were the highest since records were started at Molo. In 1952, a similar winter season occurred, and was discussed in the Annual Report for that year. The sunshine figures for two normal and two abnormal seasons are given in the table below for comparison:—

TABLE I—HOURS OF SUNSHINE

				NORMAL SEASONS		ABNORMAL SEASONS	
				1950	1951	1952	1957
July ..	..	..	..	112.8	184.2	199.0	207.9
August	..	..	..	142.2	120.4	173.3	182.5
Total ..				255.0	304.6	372.3	390.4

In a winter season when the number of hours of sunshine is abnormally high, deciduous fruit trees do not receive adequate chilling. In 1957, symptoms of prolonged dormancy in the growing and cropping season, have been more marked than at any other time during the previous ten years. In consequence, the 1957-58 cropping season is proving to be a poor one. The main plum crop was two to three weeks earlier than usual and was over very quickly. The apple crop is light, and is being adversely affected by shortage of leaves on the trees.[1]

APPLES

The following are notes on individual varieties which can now be recommended for planting in Kenya:—

Winter Banana.—A dessert, mid-season variety, which is proving successful at altitudes ranging from just over 6,000 ft. to 9,000 ft. It is vigorous, early bearing, and is recommended as a pollinator. The fruit is of attractive appearance and of fair flavour. Slightly susceptible to scab in a wet season.

Rome Beauty.—A dessert variety, mid-season to late, which makes a good combination with Winter Banana within its altitude range. It grows and crops well from 6,000 ft. but it is generally unsuccessful at over 7,000 ft. The fruit is attractive and of good quality. Recommended as a pollinator.

Jonathan.—A dessert, mid-season variety, and a good pollinator. It is not a very strong grower, and should be worked on vigorous rootstocks. The altitude range is from 7,000 ft. to 9,000 ft. The fruit is highly coloured and attractive but only of fair flavour. The trees bear good crops, and it can be recommended for commercial planting.[1]

PLUMS

The advantages to be gained by thinning plum varieties which are prone to overbearing, were described in the Annual Report for 1956, and an article on this subject was published in the *East African Farmer & Planter*, September, 1957.

Unfortunately, the results of thinning trials carried out this year, were upset by the abnormal season. Early varieties matured too early, and consequently were small in size. Late varieties suffered badly from splitting of the fruit, due to unseasonable rain.

DORMANCY BREAKING SPRAYS

An observational trial was laid down on a block of young Methley plums, (a) to determine the effect, on time of maturity and crop yield, of varying the spraying date of the dormancy breaking spray over a period of five weeks, and (b) to compare the relative effectiveness of a tar oil, and a D.N.O.C. spray in breaking dormancy.

Five plots of 80 trees each were used for the trial. One plot was sprayed each week; the first being sprayed on 22nd July, 1957, and the last on 19th August, 1957. Half of each plot was sprayed with tar oil at 5 per cent strength, and half with D.N.O.C. at 5 per cent strength; proprietary sprays were used.

No comparison of yield figures for the different treatments is possible, owing to abnormal weather conditions, the effect of which was accentuated on the young trees used for the trial. The following conclusions can, however, be drawn from the results:—

- (a) Early spraying induced earlier flowering and maturity of fruit. Spraying on 22nd July, 1957, advanced the date of first harvest by 25 days, when compared with spraying on 19th August, 1957.
- (b) Both tar oil and D.N.O.C. sprays were reasonably effective in breaking dormancy, but there was no evidence that one was more effective than the other.

The trial is to be repeated next season, using a statistical layout.[2]

CHLOROSIS OF PLUMS

Some of the plum trees in Block F at Molo suffer from a marked chlorosis of the leaves, the cause of which is unknown. It is possible that the symptoms are caused by a deficiency of certain elements in the soil; it was decided therefore to try the effect of an application of fritted trace elements (F.T.E.).

Fritted trace elements, at the rate of 4 oz. per tree, was mixed with a quantity of sand, and applied as follows:—

- (a) Sprinkled over the carefully exposed surface root system, which was afterwards re-covered with soil.
- (b) Poured into a series of holes, dug in a circle at about 3 ft. radius from the trunk.

The treatment was carried out during the dormant season in August. The trees broke dormancy in September, but no beneficial effect has been observed to date, when comparing treated with control trees.[3]

AVOCADOS

In August a small experimental consignment of Fuerte avocados grown at the Horticultural Research Station, Kitale, was despatched to Covent Garden market by air. The trial was carried out in co-operation with the Horticultural Co-operative Union, Nairobi. The fruit was well received in London and sold at Sh. 1/50 to Sh. 1/75 per fruit; the price realized was, however, insufficient

to cover the cost of handling and air freight. Both paper-wrapped and polythene-wrapped fruit was sent, but no comment was received on this. In view of the fact that the Horticultural Co-operative Union now have better facilities for distributing Kenya fruit at Covent Garden, the trial will be repeated next season.

TRIALS AT KITALE AND JACARANDA

Yield figures from observational trials of varieties, planted in 1951, are given in the table below:—

TABLE 2

STATION	VARIETY	IRRIGATED, LB. PER TREE			UNIRRIGATED, LB. PER TREE		
		1955	1956	1957	1955	1956	1957
Kitale ..	Fuerte ..	34	17	91	13	19	98
Jacaranda..	Fuerte ..		198	108		29	123
Kitale ..	Puebla ..		15	48		13	49
Kitale ..	Mayapan		88	77		46	88

Irrigation appears to have increased early yields in Fuerte at Jacaranda, and in Mayapan at Kitale; there are no other obvious effects to date, but it is likely that there will be a change in favour of irrigation when the trees are in full bearing. At Kitale, Fuerte has a cropping season of about five months; this is considerably longer than the other two varieties, and is an important factor in marketing.

MANGOES

Air export of Malindi mangoes to Covent Garden was started in January on an experimental basis. The varieties Boribo and Ngowe only were sent; these are high quality mangoes, and averaged about Sh. 4 per fruit at Covent Garden market. This price gives the grower a good return for his fruit after deduction of all expenses. Although the market for mangoes at this price is not expected to be large, there is every reason to believe that a permanent trade can be developed, provided the necessary high standard of grading and packing is maintained. The success in initiating this new project, is a good example of what can be achieved by active co-operation between different sections of the Agricultural Department, the Horticultural Co-operative Union, and Hunting Clan Air Transport.

CITRUS

It is now possible to compare the early results of observational trials of citrus kinds and varieties planted at Kitale, altitude 6,200 ft.; Jacaranda, 5,400 ft.; and Matuga, 400 ft. Trees were planted at these three stations between 1950 and 1953. All trees at Matuga are irrigated, whilst at Kitale and Jacaranda, there are duplicate plantings to compare irrigated vs. unirrigated trees. Largely owing to temperature differences between the three stations, there is a considerable variation in the period before trees come into bearing. Generally, yields at Matuga are one to two years in advance of Jacaranda, and the latter is one year ahead of Kitale. It must be emphasized that the yield figures given in the table below are only early results, it would therefore be a mistake to draw too many conclusions from them. They are, however, the only figures available for Kenya, and must serve as a guide to growers, and for planning future experimental work, until more conclusive results are available.

TABLE III—MEAN YIELD PER TREE (LB.)

KINDS VARIETY	Root- stock	Station	Date Planted	IRRIGATED			UNIRRIGATED		
				1955	1956	1957	1955	1956	1957
ORANGE									
Parson Brown ..	R.L.	Kitale ..	1952	0	55	160	0	4	57
Valencia Late ..	S.O.	Kitale ..	1952	0	45	162	0	0	48
Valencia Late ..	S.O.	Matuga	1950	15	167	483	—	—	—
Valencia Late ..	S.O.	Jacaranda	1951	0	62	146	6	80	20
Valencia Late ..	R.L.	Kitale ..	1951	0	7	56	0	16	44
Valencia Late ..	R.L.	Jacaranda	1951	2	38	157	10	43	110
Valencia Late ..	R.L.	Matuga	1950	228	264	271	—	—	—
Washington Navel	R.L.	Kitale ..	1951	0	35	78	0	13	28
Washington Navel	R.L.	Jacaranda	1951	3	50	100	3	17	55
Renmark Navel..	R.L.	Kitale ..	1951	0	2	30	0	0	2
Renmark Navel..	R.L.	Jacaranda	1951	4	26	86	14	35	65
Renmark Navel..	R.L.	Matuga	1950	309	256	309	—	—	—
Lue Gim Gong ..	R.L.	Kitale ..	1951	0	40	94	0	22	76
Lue Gim Gong ..	R.L.	Jacaranda	1951	0	72	152	13	62	95
Lue Gim Gong ..	R.L.	Matuga	1950	297	486	403	—	—	—
Sabina	R.L.	Kitale ..	1951	0	5	22	0	10	57
Sabina	R.L.	Jacaranda	1951	22	52	46	5	30	105
Hamlin	R.L.	Kitale ..	1951	0	7	53	0	0	0
Hamlin	R.L.	Jacaranda	1951	0	6	132	0	34	123
Pineapple ..	R.L.	Matuga	1950	9	295	375	—	—	—
Mediterranean									
Sweet	R.L.	Matuga	1950	52	130	402	—	—	—
Temple	R.L.	Kitale ..	1951	0	10	35	0	22	50
Temple	R.L.	Jacaranda	1951	9	77	77	21	62	40
TANGERINES									
Beauty of G.R. ..	R.L.	Kitale ..	1951	0	0	124	0	0	53
Beauty of G.R. ..	R.L.	Jacaranda	1951	0	0	23	0	1	38
Cape Naartje ..	R.L.	Kitale ..	1951	0	5	35	0	3	32
Cape Naartje ..	R.L.	Jacaranda	1951	0	5	18	0	3	69
Satsuma	R.L.	Jacaranda	1951	27	53	91	4	17	52
GRAPEFRUIT									
Marsh	R.L.	Kitale ..	1951	0	45	170	0	125	219
Marsh	R.L.	Matuga	1953	94	197	141	—	—	—
Marsh	S.O.	Matuga	1950	279	460	674	—	—	—
Thompson ..	R.L.	Matuga	1950	47	269	361	—	—	—
LEMONS									
Eureka	R.L.	Kitale ..	1951	0	57	128	0	41	103
Eureka	R.L.	Jacaranda	1951	27	170	284	62	135	129
Eureka	R.L.	Matuga	1950	256	232	372	—	—	—
Meyer	R.L.	Kitale ..	1951	0	108	133	0	117	139
Meyer	R.L.	Jacaranda	1951	104	216	37	85	143	21
Meyer	R.L.	Matuga	1950	658	511	861	—	—	—
Lisbon	R.L.	Kitale ..	1951	0	128	258	0	122	178
Lisbon	R.L.	Jacaranda	1951	30	213	328	68	97	175
Lisbon	R.L.	Matuga	1950	310	281	446	—	—	—
Villa Franca ..	R.L.	Kitale ..	1951	0	167	348	0	170	263
Villa Franca ..	R.L.	Jacaranda	1951	48	298	192	93	117	122
Villa Franca ..	R.L.	Matuga	1950	370	313	627	—	—	—
LIMES									
Mexican	R.L.	Kitale ..	1952	0	8	36	0	0	28
Mexican	R.L.	Matuga	1950	524	314	645	—	—	—
Tahiti	R.L.	Kitale ..	1951	0	10	86	0	0	79

R.L.—Rough Lemon.

S.O.—Sweet Orange.

The heavy yields recorded at Matuga would seem to indicate that this is the most suitable climate of the three in which to grow citrus. This is true provided irrigation is available, for grapefruit and the Mexican lime, which are both of high quality. The early crops of oranges were of very poor quality owing to granulation, a physiological trouble typified by drying up of the juice sacs. Granulation is, however, decreasing as the trees come into full bearing, and can be still further decreased by early harvesting. High temperatures at the coast are responsible for the very inferior greenish yellow skin colour of the oranges grown at Matuga. This is an important factor in marketing fresh oranges but not for juice production. Lemons suffer from many skin blemishes, in addition to being of poor colour; they are therefore of inferior quality.

Little irrigation can be developed at the coast. It is unfortunate, therefore, that the Matuga station is not suitably located for a trial of unirrigated citrus, which must form the main part of the acreage. Trials of unirrigated citrus are to be carried out at the new tree crops station at Mtwapa.

At Kitale and Jacaranda, irrigation has had a favourable effect on yields of some orange and lemon varieties, but at Kitale unirrigated grapefruit trees have yielded more than the irrigated. Observations made at Kitale on trees a few months after the finish of the last crop, indicate that unirrigated trees of all kinds are recovering far less rapidly from the strain of cropping. They are short of leaves, have less new growth, and show more marked symptoms of zinc and magnesium deficiency, than the irrigated trees. In 1957, unirrigated trees tended to have several small flowerings during the year, and consequently the crop ripened over a much longer period. Irrigated trees, more particularly the oranges, tended to flower only once, and therefore had a relatively short harvest. Examples are given in the table below:—

TABLE IV—PERIOD OF HARVEST OF SOME ORANGE VARIETIES AT KITALE IN 1957

VARIETY	Treatment	Period of Harvest
Valencia Late	Irrigated	25-6-2-9-57
Valencia Late	Unirrigated	27-4-24-12-57
Washington Navel ..	Irrigated	4-5-5-8-57
Washington Navel ..	Unirrigated	4-5-24-12-57
Lue Gim Gong	Irrigated	13-4-25-7-57
Lue Gim Gong	Unirrigated	29-3-24-12-57

Sweet orange as a rootstock, requires further investigation. At Matuga. Marsh grapefruit on sweet orange stock is slower to yield than when on rough lemon, but the trees are vigorous and cropping on a higher plane than the other grapefruit. Fruit quality is very good, whereas on rough lemon the fruit tends to be granulated. At Kitale, Valencia Late orange is yielding much more on sweet orange stock, than on rough lemon, though trees on the latter stock are a year older.[1][3][5]

Pineapples

Camber Bed, Black Cotton Soil Fertilizer Trial

This trial was started in November, 1954, to study the growth and yield performance of pineapples on fertilized black cotton soils when the soil was made up into 9-ft. wide camber beds.

The design was a 3³ factorial in three blocks of nine plots, each plot being split for mulch effect. The treatments were sulphate of ammonia at 0 lb., 1,120 lb.

and 2,240 lb. per acre, double superphosphate at 0 lb., 224 lb. and 448 lb. per acre and cattle manure at 0 tons, 10 tons and 20 tons per acre. The planting material was fruit crowns spaced in two-row beds at 1 ft. between plants, 1½ ft. between rows and 2 ft. between the two-row beds.

The period taken to produce the plant crop from planting to the final harvest was 25 months. The period taken to harvest the crop was eight months. Significant no-mulch treatment effects are given in Table V:—

TABLE V—PLANT CROP
Significant Treatment Effects

TREATMENTS	Yield tons/acre	Mean weight/ fruit, lb.
N ₂	1.86	0.36
F.Y.M.2	1.83	—
L.S.D.s 5 per cent	1.37	0.15

The mean of the no-mulch treatment yields, based on a plant population of 13,400 per acre, showed that this treatment produced 20 tons, the high level sulphate of ammonia, 21.8 tons, and the high level farmyard manure 21.7 tons per acre. The increase in yields as a result of the treatments was far from economic. Mulch produced no response whatever.

Fruiting was more uniform in this trial than was the case on the red loams and murrum soils. The bulk of the crop was harvested within four months.[3]

Camber Bed, Vlei Soil Fertilizer Trial

The first ratoon crop was harvested by early November, 1957, or 43 months after planting. The details of this trial and the plant crop results were published in Volume II of the Annual Report for 1956.

A summary of the significant treatment effects is given in Table VI:—

TABLE VI—FIRST RATOON CROP
Significant Treatment Effects

TREATMENTS	Yield per acre/tons	Mean weight per fruit/lb.	No. fruit per acre
N	+3.49	+0.23	+1,416
F.Y.M.	+2.34	+0.25	+998
L.S.D.s—			
5 per cent	1.38	0.17	544
1 per cent	1.87	0.23	744
0.1 per cent	2.53	0.39	1,016

The mean treatment yields from a plant population of 14,520 were 16.4 tons for the nil treatment, 22.5 tons for the 1,120 lb. sulphate of ammonia and 20.4 tons for the 10 tons cattle manure per acre.

The total yields per acre over the two crops was 39.2 tons for the nil treatment, 48.9 tons for the sulphate of ammonia and 47.6 tons for the cattle manure. The treatments proved highly economic in this trial.

Interbed, Fertilizer and Mulch Trial

Having produced its first ratoon crop the trial is now concluded. The details of this trial and the results of the plant crop were published in Volume II of the Annual Report for 1956. The period from planting to the final harvest of the first ratoon crop was 47 months. The significant treatment effects are given in Table VII:—

TABLE VII—FIRST RATOON CROP
Significant Treatment Effects

TREATMENTS	LEVELS			L.S.D.s	
	1	2	3		
N	+4.6***	+2.2***	—0.4**	0.41**	0.56***
K	—2.8**	—	—	0.29**	
(Yield per acre/tons)					
N	0.47**	0.31**	—	0.36**	
(Mean weight fruit/lb.)					

Potassium has very significantly decreased the yield and it is suspected that this result was due to antagonizing magnesium uptake. Superphosphate or mulch has had no significant effect.

Mean treatment yields from a plant population of 10,000 per acre were 8.5 tons for the nil treatment, and 12.4 tons, 10.9 tons and 9.1 tons respectively for the 1, 2 and 3 levels of sulphate of ammonia. The higher level N_1 treatments produced the best results and proved highly economic.

The yields over the two crops from the nil and high level N_1 treatments were 16.3 tons and 24.9 tons per acre respectively.[3]

Spacing and Mulch Trial

This trial has now produced its first ratoon crop. Details of the trial and yield results of the plant crop were published in Volume II of the Annual Report for 1955. The period from planting to final harvest for the first ratoon crop was 47 months. Significant treatment results from the unmulched spacings used in the trial are given in Table VIII:—

TABLE VIII—FIRST RATOON CROP
Significant Treatment Effects

TREATMENTS					Yield per acre/tons
Plants per acre					
12,000	..	..	..	..	2.86
17,000	..	..	..	..	7.67
L.S.D.s—					
5.0 per cent		..	..		2.43
1.0 per cent		..	..		3.82

The mean treatment results show that the yield per acre from 10,000 plants, which was the control spacing, was 15.0 tons. For the 12,000 plants and 17,000 plants per acre the yields were 17.9 tons and 23.4 tons per acre respectively.

This trial has proved that the close, double-row Hawaiian spacing of 1 ft. between plants, 2 ft. between the rows and 3 ft. between each double row, giving 17,000 plants per acre is far more economic than the now obsolete spacing which gave only 10,000 plants per acre.

Over the two crops the total yield from the 17,000 plants per acre spacing was 50.6 tons. From the 10,000 plants per acre spacing the yield was 30.7 tons.[3]

Trace Element and Soil Fumigation Trial

The first ratoon crop of this trial has now been harvested. Details of the trial and yield results of the plant crop were published in Volume II of the Annual Report for 1955. The period of the trial from planting to the final harvest of the first ratoon crop was 48 months. Though copper at 0.5 per cent significantly suppressed yields in the plant crop there was no significant difference, as a result of the treatments, in the first ratoon crop. A summary of the treatment effects is given in Table IX:—

TABLE IX—FIRST RATOON CROP
Summary of Treatment Effects

TREATMENTS	Yield per acre/tons	Mean weight/ fruit, lb.
(1)	25.5	3.62
Cu. 0.5 per cent	25.5	3.59
Cu. 0.5 per cent	23.5	3.41
Mn. 0.5 per cent	21.6	3.34
Cu. 0.25 per cent Mn. 0.5 per cent	26.1	3.75
Cu. 0.5 per cent Mn. 0.5 per cent	17.0	3.31

Although the differences are not statistically significant there is still a strong suspicion that copper at 0.5 per cent and manganese at 0.5 per cent and also copper at 0.5 per cent + manganese at 0.5 per cent has continued to suppress yields.

Total yield over the two crops from the nil treatment was 51.4 tons per acre.[3]

Foliar Sprays of Urea

A considerable number of test sprayings with pelleted urea have been carried out during the year to determine the optimum concentration which may be used for field treatment during all seasons of the year. Concentrations from 2 per cent to 40 per cent, by weight, have shown that while very high concentrations can be used during the rainy season, or when the soil is very moist, no more than a 5 per cent concentration is safe during the dry season, or dry soil conditions.

Though a 40 per cent spray can do considerable damage, one-year-old plants were not destroyed by such a high concentration. On the contrary, plants sprayed in the middle of a very dry period, though seriously burned as a result of the spray, showed almost complete recovery five months later though there was still considerable growth suppression.

Colour response to urea foliar sprays is good but is not considered to be quite so effective as ground applications of sulphate of ammonia applied at the same rate, in terms of units of nitrogen per acre.[3]

Comparison of N. Fertilizers

The indications are that urea in ground applications is unlikely to be so effective as sulphate of ammonia but a trial is now in progress to study both ground and foliar applications to find out which of these fertilizers will prove the more effective and economic.[3]

Herbicides

Various observational trials are in progress to study the effect of herbicides on couch and broad-leaved weed species. The results so far achieved show that couch can be controlled, in pineapples, by using dalapon at the rate of 10 lb. per acre. The effective period of control in badly infected areas is from nine months to one year. Lower rates are promising but the indications are that lower rates, in the region of 5 lb. per acre, though they will control couch, will need reapplication more frequently. There is no indication, as yet, that couch can be completely eliminated. Moreover, the effect of dalapon on young plants up to 14 months old causes yellowing of the foliage and slight suppression of growth. On ratoon plants, however, there have been no visible unfavourable effects whatever. This is important because couch control in ratoon crop pineapples is considered to be of great economic importance because, while couch can be controlled by hand cultivation during the plant crop period, it is almost impossible to control it during the ratoon crop, and tremendous financial loss to a grower can be the result.

Of chemicals used for the control of broad-leaved weed species, Karmex W has been the most promising. Even so, the results so far achieved are not considered of economic value. A trial was started in November, 1956, using Karmex at 10 lb. per acre, but this amount showed no weed control whatever. Retreatment was carried out in October, 1957. The following short rains season was good and heavy weed growth resulted, but this time the treatment had a very marked effect indeed, though there was no effect on couch.[3]

Pineapple Trials in Nyanza

These observational trials were planted in 1954, a previous report on them was published in Volume II of the Annual Report for 1956. The first ratoon crop has now been harvested, and the results confirm the conclusion reached after the plant crop, that good economic returns can be obtained from pineapples in Nyanza, in so far as yields are concerned. The problem of developing pineapples in Nyanza is now one of marketing.

The prospect of a pineapple cannery being established in the province is now remote, but as already reported, Nyanza fruit is of particularly good quality for the fresh market. Apart from the considerable quantities of fruit which will undoubtedly be consumed within the province, it should be possible to market a proportion of the crop at other centres of population.[6]

Trial with Sulphate of Ammonia and Mulch at Kitale

This trial was planted in July, 1953, a previous report on it was published in Volume II of the Annual Report for 1956. The treatments were (a) sulphate of ammonia at the rate of 1,500 lb. per acre, (b) mulch, (c), (a) plus (b), (d) control.

The layout is duplicate plots of 300 plants each.

With the harvesting of the second ratoon crop the trial is complete. Final results are given in the table below:—

TABLE X—MEAN YIELD AND MEAN WEIGHT OF FRUIT

TREATMENT	1955, PLANT CROP		1956, 1ST RATOON		1956, 2ND RATOON		Total Tons/ acre
	Tons/ acre	Fruit- weight	Tons/ acre	Fruit- weight	Tons/ acre	Fruit- weight	
		<i>lb.</i>		<i>lb.</i>		<i>lb.</i>	
(a) N	12.62	3.93	10.24	3.95	14.39	2.73	37.25
(b) Mulch ..	5.51	2.83	7.43	2.86	9.84	2.61	22.78
(c) N + Mulch	12.74	3.93	11.26	3.62	13.35	2.78	37.35
(d) Control ..	5.17	3.24	13.52	2.87	8.88	2.72	27.57

The results show that the use of sulphate of ammonia at 1,500 lb./acre gave an economic return. All of the fertilizer was applied during the first year after planting, and the residual effect can clearly be seen. There was no benefit from applying mulch with sulphate of ammonia, and mulch only had a depressing effect on yield. The total yield figure for the N treatment is considered to be rather low, and the fruit was not as large as it should have been. It is probable that sulphate of ammonia at the rate of 2,000 lb./acre would have given a much better result, as has been indicated in trials at Thika. The fruit produced was particularly good as regards shape, skin colour, and flavour, when compared with Thika pineapples. It is fruit of this quality which is required for the fresh export market.[1]

STRAWBERRY BREEDING

Berry Fruit

It has been felt for some time that the importation of strawberry varieties from the United Kingdom does not provide the most suitable type of plant for commercial production in Kenya.

Varieties bred for one climate are seldom ideally suited to another which is quite different. It was decided, therefore, to attempt the production of local varieties which would be better suited to our climatic conditions. As facilities at Molo do not permit a planned breeding programme, mass selection of seedlings has been resorted to. Parent plants of the more promising imported varieties were grown in close proximity and seed collected from each variety separately. Thus if cross fertilization takes place, only the female parent is known. Seedlings have been raised from the seed produced in this way, and several thousand planted out. Most of these have now borne fruit, and a few plants have been selected as being promising enough to warrant further trial. It is encouraging to note that many of the seedlings are extremely vigorous, and very few of them are susceptible to strawberry leaf spot.[1]

THE MOLO SYSTEM FOR STRAWBERRIES

It is now possible to recommend a more definite cycle for strawberry culture for Molo and similar climates. The essentials of this system have already been described in the press, and in the Annual Report for 1956, Volume II.

The cycle is as follows: (a) Deflower plants for eight months after planting, (b) crop for two months, (c) deflower for six months, (d) crop for two months, and so on up to 34 months from planting, which is the end of the cycle. The plants must now be lifted, divided, and replanted, preferably on a piece of land which has not grown strawberries for two years. This system is only possible if the plants can be irrigated. At lower altitudes than Molo, strawberries do not flower all the year round, and the period of deflowering will thus be shorter.

In order to spread the harvest over as long a period as possible, rotational planting and cropping should be practised, but cropping during periods of heavy rain should be avoided. The variety Cambridge Early Pine crops consistently at the rate of 6 tons of fruit per acre during each two-month cropping period of the cycle.[1]

STRAWBERRY VARIETIES

Cambridge Profusion, which has been under trial at Molo, has not made satisfactory growth. It is not recommended for Molo and similar climates.[1]

SHANK'S BLACKBERRY

The plants start to bear at one year after planting out. The crop is not yet complete, but the recorded yield after nine months' continuous bearing is at the rate of 6 tons per acre.[1]

Cucurbits

A cucumber trial was carried out at Rongai, and a melon trial at Perkerra Irrigation Scheme, with the objects of finding suitable varieties of these crops for local conditions, and of testing malathion bait as a control for melon fly, *Dacus Cucurbitae*. This pest is a limiting factor in successful production of many cucurbits in Kenya.

In both trials melon fly was successfully controlled by applying malathion bait to the plants, at fortnightly intervals from flowering onwards. The formula used was malathion 1 part, molasses 8 parts, water 64 parts. The mixture was sprayed on the plants in large droplets, using a stirrup pump.

CUCUMBER VARIETY TRIAL

A trial of 15 varieties was carried out at Rongai, 6,000 ft. altitude. No irrigation was available. Single plots were planted of each variety, but in addition, eight varieties were planted on ridges also, to compare yields from this method of planting. The land was given a dressing of farmyard manure at the rate of 15 tons per acre before planting. Seed was sown direct at a spacing of 4 ft × 5 ft. All plots were mulched with grass, when the plants had made 1-2 ft. of growth. Results are given in the following table:—

TABLE XI

VARIETIES	Date Sown	Date Com-menced Harvest	TOTAL CROP YIELD PER SIX PLANTS		Pests and Diseases
			On the Flat	On the Ridge	
Hybrid Saladeer ..	25-6-57	5-8-57	lb. 65	16 57	Slight aphid attack.
Robin 50	"	"	53	49	"
Hybrid Superslicer ..	"	"	46	51	"
Sutton's Long Green	"	2-8-57	45		Aphis, mosaic and mildew.
S.B. Ideal	"	5-8-57	39	53	Slight aphid attack.
S.B. Delicacy ..	"	"	35	64	"
Sutton's King of Ridge	"	9-8-57	35		Aphis, mosaic and mildew.
Davis Perfect ..	"	2-8-57	30		Aphis and mildew.
Crystal apple ..	"	12-8-57	30		Slight aphid.

The following varieties failed through disease, and are considered to be unsuitable for the climate:—

Japanese Climbing, Open-air Telegraph, Butcher's Frame Disease Resister, Rochford's, Palomar, Santee.

Rainfall during the period of the trial was 37.78 in.; the major part falling early in the trial, was the cause of mildew attack. Lack of rain towards the end of harvest caused most fruits to develop a bitter taste. The average harvest period for all successful varieties was two months.

The three American varieties Hybrid Saladeer, Hybrid Superslicer and Robin, together with the two Dutch varieties, S.B. Ideal and S.B. Delicacy, are by far the most suitable types for our climatic conditions. The plants of the hybrid type are most resistant to disease, and are better in shape, colour and size than the English varieties grown under similar conditions. The variety Robin 50 is comparable with the hybrid types although slightly smaller; the fruits, however, tend to yellow very quickly if not harvested at the correct stage of maturity. S.B. Ideal and S.B. Delicacy produced excellent fruits; average length, 10 in., and weight from 2-3 lb. per fruit. Unfortunately, the shape of the fruit makes it difficult to pack for market.

Most of the other varieties were badly attacked by diseases and the majority of English varieties even when the yield was good, exuded a gummy substance which presumably was caused by high temperatures.[2]

MELON VARIETY TRIAL

A trial of six varieties was sown on 10th May, 1957, at the Perkerra Irrigation Scheme. Duplicate randomized plots of each variety were sown direct, at a spacing of 4 ft. × 6 ft., on sloping ridges. After thinning the seedlings, all plots were mulched with grass. The plants were deflowered on 13th June, 1957, in order to avoid weakening them by over-early fruiting; they were allowed to flower from 19th June, 1957.

Irrigation during the period of the trial was at the rate of approximately 1½ in. per week. The cropping period of the water melons was about one month, and of the cantaloupes two weeks, the latter being shortened by disease. Yields are given in the following table:—

TABLE XII

VARIETY AND CROP YIELDS						Yield per 8 plants
WATER MELONS EX U.S.A.—						lb.
Irish Grey	..	..	..	..	..	184
Fairfax W.R.	..	..	..	..	..	249
Striped Klondike Blue Ribon	..	..	..	..	..	210
CANTALOUPE—						
Imperial No. 45	..	..	..	..	..	48
Imperial No. 6	..	..	..	..	..	47
Texas M.R. No. 1	..	..	..	..	..	62

The water melons showed very vigorous growth and all varieties did extremely well. Of the three types, Irish Grey has little use except for jam-making owing to its colourless flesh, but both Fairfax W.R. and Striped Klondike Blue Ribon are pink-fleshed types and acceptable on the fresh market, although the fruits are enormous, being between 20 and 25 lb. in weight. Their exceptional size makes them rather difficult to sell and a trial with smaller fruiting varieties is suggested.

The cantaloupes did not do as well as the water melons, being affected by a disease of the stem which is believed to be *Fusarium* wilt, though this has not been confirmed. Of the few fruits harvested, the quality was high and it is hoped to repeat the trial when more information concerning the stem disease is available.[2]

Asparagus

SEASON OF CUTTING TRIALS

In Kenya, asparagus can be grown from the coast, up to altitudes of over 8,000 ft., but it does not have a very definite season of dormancy, as it does when grown in a temperate climate. Under temperate conditions, the harvesting season begins as soon as the crowns start into growth in Spring, and it is restricted to this period. Under our climatic conditions, though it is possible to harvest asparagus at any time of the year, it is difficult to decide for any particular climatic zone in what months to harvest the crop in order to produce the heaviest yield. It is obviously an advantage, from the marketing point of view, to extend the harvesting period over as many months as possible during the year, but this can only be done economically if an approximate forecast of the yield for each month can be made. Further reasons for finding the months of economic yield are: to be able to export asparagus to overseas markets at times when their normal supplies are out of season, and prices are therefore high; and to be able to supply canneries at periods of the year when they are not fully occupied with processing other crops. Several trials designed to provide the answers to these questions have been laid down in different climates; those at Molo and Kakamega have now started to yield, and it is possible to give some early results.

THE MOLO TRIAL

The design is four randomized blocks, with 12 plots per block. The plot size is 45 running feet of row, or 45 plants. The spacing is 7 ft × 1 ft. There are 12 treatments, i.e. harvesting monthly throughout the year, for the normal cutting period of two months, though in the first season of harvesting the cutting period is only one month. The harvest period is started by cutting back all the fern on the appropriate plots on the first day of the month, the crowns are then earthed up, and the first cutting of spears takes place about five days later. The results to date are given in the following table:—

TABLE XIII

CUTTING PERIOD FOUR WEEKS, STARTING ON THE FIRST DAY OF EACH MONTH

TREATMENT	Rainfall	Mean Soil Temp.	Yield, lb. per acre
May, 1956	4.09	64° F.	700
June	5.52	63°	700
July	6.46	60°	210
August	5.53	62°	140
September	4.76	65°	630
October	1.65	66°	700
November	2.93	64°	245
December	1.00	65°	560
January, 1957	3.12	66°	910
February	0.19	67°	980*
March	2.99	67°	1,750**
April	7.77	67°	1,260*

CUTTING PERIOD EIGHT WEEKS, STARTING ON THE FIRST DAY OF EACH MONTH

TREATMENT	Rainfall	Mean Soil Temp.	Yield, lb. per acre
May-June, 1957	16.51	65°	761*
June-July	13.51	62°	568
July-August	7.90	62°	481
August-September	8.21	61°	481
September-October	6.34	66°	1,548**
October-November	2.31	63°	705
November-December	5.10	61°	271

For the four weeks' cutting period, the March yield is significantly higher than all other yields at the 1 per cent level. For the eight weeks' cutting period, the September/October yield is significantly higher than all other yields at the same level of probability. There appears to be a correlation between high soil temperature and high yield. The most unsuitable periods for harvesting are June to August, and November.[1][2]

THE KAKAMEGA TRIAL

This trial is at an altitude of 5,200 ft., which is 3,000 ft. lower than the Molo trial. The design is the same as Molo. Yield results for six cutting periods in 1957 are given in the following table:—

TABLE XIV

CUTTING PERIOD EIGHT WEEKS, STARTING ON THE FIRST DAY OF EACH MONTH

TREATMENT	Yield, lb. per acre
June-July	428.1
July-August	183.7
August-September	615.5
September-October	845.1+++
October-November	318.9
November-December	282.9

Of the six periods so far recorded, it appears that September and October are the best months for cutting. Yields at this time are significantly higher, at the 1 per cent level of probability, than at all other times, except the July/August period which is significantly outyielded at the 0.1 per cent level.[6]

It is interesting that in two entirely different climates, September/October gave significantly the best yield in 1957. It must be emphasized, however, that reliable results on which crop forecasts can be made, will require these trials to be continued for at least five years.

Tomatoes

An article on the production of canning tomatoes was published in the *East African Farmer & Planter*, March, 1957.[1]

A number of canning tomato trials have been carried out at Mwea/Tebere, and the Perkerra Irrigation Scheme. Those at Mwea/Tebere will be reported on separately by the Agricultural Officer (Irr. Res.) in the section entitled "Annual Report for Irrigation Investigations, 1957".

These trials, which are described below, were all carried out at Perkerra. Owing to lack of experimental facilities there, the trials were started rather late in the season, the results, therefore, may not be so good as they would otherwise have been.

SPACING AND STAKING TRIAL

The object of this trial was to find the most suitable spacing for the variety San Marzano, when grown unstaked, and to compare the yield from the same variety when staked.

The layout was five randomized blocks, each of five plots, and the treatments were as indicated in the table of results below. Seed was sown direct on 20th May, 1957; the harvest began on 21st August, 1957, and ended on 18th November, 1957. Furrow irrigation was maintained throughout the trial at approximately $1\frac{1}{2}$ in. per week. No blight was observed and incidence of sun scorch on the fruit was negligible. Yield results are given in the following table:—

TABLE XV

TREATMENT	Yield, lb. per acre	Per cent
Spacing 4 ft by 2 ft, staked	17,581	86.6
Spacing 8 ft. by 1 ft.	18,628	91.7
Spacing $5\frac{1}{2}$ ft. by $3\frac{1}{2}$ ft. by 2 ft.	26,548*	130.7
Spacing 7 ft. by $1\frac{1}{2}$ ft.	19,281	94.9
Spacing 6 ft. by $1\frac{1}{2}$ ft.	19,534	96.2
Mean	20,313	100.0
C.		3.0

The yield from the spacing $5\frac{1}{2}$ ft. $\times$ $3\frac{1}{2}$ ft. $\times$ 2 ft. is significantly higher than yields from all other treatments at the 1 per cent level.

It is noteworthy that, after all the controversy over the staking of canning tomatoes, the staked treatment has given the lowest yield in the trial. However, the plants in this treatment looked less healthy even before cropping started, than those in the unstaked treatments. Our policy of not staking canning tomatoes is therefore vindicated, because in order to make staking an economic proposition, it would be necessary for staked crops to yield several tons more fruit per acre.

Yield from the double-row spacing, $5\frac{1}{2}$ ft. $\times$ $3\frac{1}{2}$ ft. $\times$ 2 ft., is outstanding, and it is recommended that this spacing should be adopted as standard for all future plantings of canning tomatoes.[2]

TRIAL OF STOKESDALE VARIETY

In order to test the suitability of this variety for the Perkerra climate, and as a canning tomato, duplicate plots of $1/20$ th acre were sown at a spacing of 6 ft. $\times$ 2 ft. The plants in one plot were treated with a nutrient solution, at the rate of two gallons per plant, when 10-12 in. high. The solution used was sulphate of ammonia 5 lb., triple superphosphate 5 lb., water 40 gallons.

The initial increase of growth of the treated plants was considerable, but after two months had elapsed there was no apparent difference between the plants in the treated and control plots, and no difference in the yield. It would be worth while to try in a future trial the effect of two or more applications of nutrient solution.

When flowering began, the plots were split for spraying at weekly intervals with "Planofix", a hormone preparation to increase fruit setting and control. Flower trusses which were marked after spraying, showed a higher percentage of flowers setting fruit, and an increase in fruit size and quality. Yields were as follows:—

Sprayed "Planofix"	Control	Mean Yield, tons per acre
1,401 lb.	1,311 lb.	12

A sample of the fruit submitted to Kabazi Cannery was favourably reported on for canning quality. Colour and flavour of juice was good.[2]

Onions

An article on the production of onions was published in the *East African Farmer & Planter*, May, 1957.

VARIETY TRIAL, MACHAKOS

Single plots of four varieties of onion were tried on bench terraces at Kangundo, Machakos. Before planting, the land was manured with farmyard manure at the rate of 20-25 tons per acre. Seed was sown on 26th August, 1957, the seedlings transplanted on 31st October, 1957, and the crop harvested on 29th January, 1958; thus the period to maturity was five months. Rainfall from transplanting time to harvest was 21.54 in. Yields were as follows:—

VARIETY	Yields, lb. per acre
Bombay Red ..	8,175
Cape Flat ..	12,503
Texas Grano ..	11,760
Granex ..	14,553

It was considered that Bombay Red produced bulbs of the most suitable size and quality for the market, and it has the additional advantage of being a good keeper. In spite of its lower yield in the trial, this variety is therefore likely to be more suitable for planting in Machakos than the other varieties tried.[7]

T. H. JACKSON,
Senior Horticultural Officer.

References

The officers responsible for carrying out the work described in this report are designated by numbers at the end of each section.

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ANNUAL REPORT OF THE SENIOR PYRETHRUM OFFICER, 1957

Meteorological

Detailed meteorological records for the various stations will be found in the Appendix to this Report.

The year started with untimely rains in January which gave a boost to the pyrethrum, especially the 1956 plantings. More rain fell towards the middle of March but there was not enough for planting until the second half of April when a large portion of the experimental programme was put down. At least west of the Rift Valley the season was unusual in so far as the rainfall during both July and August was well below normal and failed almost completely in September and October. This interfered with planting and also caused a setback to flowering with the result that, in many areas, the yield per acre will be lower than in previous years. The welcome rains in November and early December saved a good deal of the plantings and gave a renewed impetus to the fields established during 1957, but came too late in most areas to have much effect on older plantations. On the other hand, the climatic conditions seem to have favoured an increase in the thrips population to an unprecedented extent and this also had a depressing effect on yield in many cases. The total flower production in the Colony was 7,543,022 lb. as compared with 7,037,289 lb. in 1956. The increase by 505,733 lb. is the result of enlarged plantings. The average pyrethrins content was 1.46 per cent, by 0.04 per cent lower than in 1956; this may be due to the comparatively high mean temperatures prevailing during most of the months in the growing season and caused through long, sunny spells between the rains. These had also the effect of keeping the incidence of *Ramularia* bud disease at a fairly low level, at least in most regions. Losses of buds through physiological disturbances were, however, observed quite frequently and deserve further investigation.

Experimental Work

PHOSPHATE/RIDGING TRIALS

A total of 27 fertilizer trials was either planted or maintained.

The most interesting results can be reported from a trial planted in 1955 on the Grassland Station, Molo, with clone 486. Over the first two seasons, the average yield increases achieved through the application of superphosphate and ridge planting respectively were 322 lb. and 213 lb./acre dry flowers (significant at $P = 0.01$). In the third year, 1957, ridge planting had no further effect, possibly due to the comparatively long, dry spells prevailing during the growing season, while the results for the phosphate treatments were as follows:—

TREATMENTS	Yield in lb./acre dry flowers
No fertilizer	lb./acre
150 lb./acre triple supers.	662
300 lb./acre triple supers.	854**
450 lb./acre triple supers.	900**
	905**

(**significant at $P=0.01$).

Although another small trial specially designed to test the availability of phosphorus in the seasons following the application has given only inconclusive results, there seems a strong indication for a residual effect of the superphosphate in this experiment. The total yields for all three seasons were as follows:—

TREATMENTS	Yield in lb./acre dry flowers
	<i>lb./acre</i>
On flat, no fertilizer	1,686
On flat, 150 lb./acre triple supers, in planting holes	2,190**
On flat, 300 lb./acre triple supers, in planting holes	2,167**
On flat, 450 lb./acre triple supers, in planting holes	2,038
On ridge, no fertilizer	1,753
On ridge, 150 lb./acre triple supers, below ridge	2,298**
On ridge, 300 lb./acre triple supers, below ridge	2,444**
On ridge, 450 lb./acre triple supers, below ridge	2,455**
Av. effect of Supers	+456**
Av. effect of Ridge Planting	+217**

(**significant at $P=0.01$).

Applications heavier than 150 lb./acre triple superphosphate have given no additional responses of statistical significance and it is considered that on Molo veldt soils of reddish colour and other similar soil types a dosage of 150 to 200 lb./acre is adequate.

An experiment identical to the one discussed above has been planted on the South Kinangop plot.

Of the other trials, mention should be made of two sited on Mr. H. R. Munro's farm, Dundori, and Mr. V. A. W. Schalch's farm, Thomson's Falls. Results over the last season follow below (yields in lb./acre dry flowers):—

TREATMENTS	Dundori	Thomson's Falls
On flat, no fertilizer	176	470
On flat, 150 lb./acre triple supers, in planting holes	232	719**
On flat, 300 lb./acre triple supers, in planting holes	285*	716**
On flat, 600 lb./acre F. kenaf, in planting holes	260	—
On ridge, no fertilizer	272*	496
On ridge, 150 lb./acre triple supers, below ridge	308**	717**
On ridge, 300 lb./acre triple supers, below ridge	350**	844**
On ridge, 600 lb./acre F. kenaf, below ridge	378	—
Av effect of Supers	78*	266**
Av. effect of Ridge Planting	89**	51

(*Significant at $P=0.05$).

(**Significant at $P=0.01$)

At Dundori, phosphate applied on the flat has given a significant yield increase ($P=0.05$) in one case only, while ridge planting has boosted the effect of the fertilizer. In the Thomson's Falls trial, the yields have been influenced in a much more pronounced way through the superphosphate. Both experiments are sited on reddish, rather poor soils of the veldt type which are also deficient in calcium and potash. Work has been started to investigate the demand for these two minerals.

An older trial (planted 1955) at Dundori on the same soil showed a yield increase of 619 lb./acre over three seasons through the application of 300 lb./acre triple superphosphate ($P = 0.01$) while 750 lb./acre soda phosphate (Kenaf) caused a response of 250 lb./acre ($P = 0.01$). The yield difference between the superphosphate and soda phosphate plots was also significant ($P = 0.01$).

Again this year, most of the soils on which fertilizer trials were put down were analysed by the Soil Chemists of E.A.A.F.R.O. and it was thought that a correlation could be established between the reaction to phosphorus and the saturation percentage of the base exchange capacity; only where this was 60 per cent or below were responses recorded.

TRIALS COMPARING DIFFERENT TYPES OF PHOSPHATIC FERTILIZERS

An observation in the field at Londiani indicated an enhanced action of basic slag as compared with that of superphosphate and it was considered important to follow this up with a number of controlled trials. Eleven of these experiments have been planted in different areas but some of them, owing to the peculiar weather conditions of the season, have not yet yielded any results. In order to check up on a possible lime effect of the basic slag on rather acid soils, a plot is included receiving the equivalent amount of lime as contained in the slag. The trial on the Molo station, planted with clone 1820, has yielded the following results up to date:—

No Fertilizer	..	..	..	..	381 lb./acre dry flowers
425 lb./acre Agricultural Lime	..	..	..	..	340 lb./acre dry flowers
500 lb./acre Basic Slag	..	..	..	..	560 lb./acre dry flowers
200 lb./acre Triple Supers	..	..	..	..	588 lb./acre dry flowers

In the first season at least, in this and several other trials, neither of the phosphatic fertilizers has shown itself superior to the other. It is, however, interesting that phosphorus has produced such a marked yield increase on a soil which, in previous years and in several trials, has given no responses to this element. This is all the more remarkable as the land on which the trial is sited has been under a grass ley for four years.

Marked initial responses to both superphosphate and basic slag were also recorded at upper Ol Joro Orok on General Smallwood's farm.

A similar trial on the Grassland Station, planted with clone 194, has given the following preliminary results:—

No Fertilizer	..	..	..	..	107 lb./acre dry flowers
200 lb./acre Triple Supers	..	..	..	..	252 lb./acre dry flowers
450 lb./acre Basic Slag	..	..	..	..	210 lb./acre dry flowers
450 lb./acre Kenaf (soda-phosphate)	..	..	..	..	204 lb./acre dry flowers

While there is no marked difference in the action of the various fertilizers, planting on the ridge yielded 51 lb./acre more dry flowers than on the flat.

The Spectrochemist of E.A.A.F.R.O. undertook analyses of leaf material from plots treated with superphosphate and basic slag respectively. No difference in the composition could be detected.

VARIETY/PHOSPHATE TRIAL

Ten of the newer varieties were planted on the Grassland Station with and without triple superphosphate (200 lb./acre) to investigate whether some of these responded to a greater or lesser degree than others. This large trial is still flowering heavily. In all varieties yield increases through phosphorus have been recorded, the average increase being 66.6 per cent.

MULCH TRIAL

Mulching at the colder altitudes has given only discouraging results, but at the warmer places indications have often been to the contrary. An experiment was put down, therefore, on the Subukia sub-station to compare an untreated control with plots covered with a grass mulch about 4 in. thick all over and others which were mulched between the rows of plants only (half-mulch) leaving bare ground around the plants. All treatments were split for weeding by hand and by chemical means respectively. This last has been a failure, causing a severe setback of the pyrethrum. The yields were:—

Control (no mulch)	..	..	..	..	714 lb./acre dry flowers
Half Mulch	..	..	..	..	835 lb./acre dry flowers
Full Mulch	..	..	..	..	764 lb./acre dry flowers

Provided that the operation can be carried out reasonably economically, half-mulching may be of considerable interest to growers at the lower altitudes.

VARIETY/CULTIVATION TRIAL

This is a large experiment planted on the Molo station with 12 varieties which have either already been issued or will be issued shortly. The object is to test these varieties at different spacings (2 ft. $\times$ 1 ft. and 3 ft. $\times$ 1 ft.) and two cultivation methods (on the flat and on the ridge). While it is not intended to repeat spacing trials which have given a fairly clear answer in the past, it is still possible that certain varieties prefer, say, a wider spacing to a narrower one or vice versa and also react differently to ridge planting. Preliminary results for the first season show an increase in flower yield through planting on ridges (42 lb.) and employing a narrower spacing (77 lb.). This last is nothing unusual and must be expected while the splits have not yet achieved their maximum size.

Rotation Trial

This trial was started in 1947 at Ol Joro Orok to determine the most suitable place for pyrethrum in a practical rotation. Treatments include rotations with grass leys of three and six years' duration respectively, a rotation with grass and cereals and with cereals only. The control consists of permanent pyrethrum plots which are being replanted every third year. The plots under grass are being grazed by sheep. The experiment has now completed its eleventh season, but so far no significant yield differences between the various treatments have been recorded. Although the structure of the surface soil is obviously deteriorating under continuous pyrethrum cropping, it seems that the deep root system of the plant has a beneficial effect on the lower layers. This might also explain, at least in part, the fact that cereal crops following pyrethrum invariably produce good yields. It has also not been found, contrary to expectations, that the plants succumb to a heavier eelworm attack under constant pyrethrum cropping. One would, nevertheless, not recommend such a policy and experiences in other parts, for example the Belgian Congo where pyrethrum is grown in monoculture, indicate clearly a steady decline in yields over a certain period, particularly if the land is on a steep slope.

Plant Breeding

The routine work of selecting single plants and producing new hybrids through crossing in isolated plots continued. Altogether 560 new clones were selected and a total of 771 was under test at the various stations. Thirty-two new crosses (hybrids) were made and 12 large isolated plots were maintained for the continuation of the "sugar beet" breeding systems at Molo and Subukia. This work seems to show promise and it is planned to make the first seed issues from these schemes in 1958. Seed production fields for C.43, C.47, C.60, C.79 and 100A were maintained and new ones established for M.9, M.11 and M.15. Eleven clones were bulked up under irrigation at Londiani for the issue of further hybrid seed in 1958 and 1959. A number of tested single plant selections were bulked up and there is now a store of 312 of these clones which are available for further breeding work or for direct issue to the growers. Seventeen yield trials in their first, second and third stages respectively were either planted or maintained in various parts of the pyrethrum-growing areas to test new hybrids and other varieties for their behaviour, yield, pyrethrins content, etc., under differing conditions.

Apart from older varieties such as 100A, C.43, C.51, C.79, C.92, M.11, M.15, O.1 and O.4, quite a number of the later hybrids showed promise in several trials, mainly M.21, M.31, M.33, M.34, M.41, M.42, M.43, M.44, M.47, M.49, O.12, O.17 and O.18. The following quantities of seed were harvested and supplied to the Pyrethrum Board for distribution to the growers:—

	lb.
100.A	965
Ol Joro Orok Bulk	41
Subukia Bulk	333
C.43	340
C.47	276
C.51	83
C.60	36
C.79	55
Total	<u>2,129 lb.</u>

The Senior Pyrethrum Officer wrote a report on the progress made in plant breeding since 1946 which was published by the Pyrethrum Board.

More work was undertaken on the botanical aspects of the pyrethrum flower and Mr. J. J. Njoroge, Assistant Agricultural Officer (Pyrethrum) wrote a paper entitled "Some Studies on Pollination in Pyrethrum" which was circulated by the Pyrethrum Board.

Pests and Diseases

Especially at the altitudes below 9,000 ft. the incidence of the bud disease caused by the fungus *Ramularia bellunensis* was not very common. Long, sunny intervals between the rains were not conducive to the spread of the fungus.

Physiological (false) bud disease was frequently observed and requires further study. Root knot eelworm (*Meloidogyne* sp.) is a very common pest in Kenya pyrethrum and can evidently cause severe harm especially in combination with poor soil conditions, drought, etc. A series of trials with fumigants, mercury compounds and heavy dressings with organic matter has been started in the Molo nursery to study the possibility of producing seedlings free from eelworm. An unusual and widespread attack by thrips (*Thrips tabaci*) was observed from the beginning of the year. Contrary to happenings in previous attacks, the pest did

not diminish in severity with increasing rains and extensive spraying operations had to be undertaken to combat it. Even so, quite a number of plants were lost as their foliage was destroyed by the insect. On the experiment stations it was found that repeated spraying with 25 per cent D.D.T. emulsion at the rate of three pints per acre controlled the pest effectively. It is important to give a good cover to the plants, which means that a minimum of 40 to 50 gallons of water must be used per acre. In certain cases the frequent D.D.T. treatment led to an outbreak of Red Spider Mite, probably through the destruction of its natural predators. Various insecticides, acaricides and ovicides were tested in co-operation with the Entomologists of the Department. Malathion, at two pints to the acre in 40-50 gallons of water, seems to give reasonable control.

Acknowledgments

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U. KROLL,
Senior Pyrethrum Officer.

APPENDIX
METEOROLOGICAL DATA
(a) *Molo (Altitude 8,300 ft.)*

1957				Mean Temp.	Rainfall	Sunshine
				<i>°F.</i>	<i>in.</i>	<i>hrs.</i>
January	..	..	..	56.9	3.12	243.0
February	..	..	..	57.1	0.79	229.7
March	..	..	..	58.3	2.99	236.1
April	..	..	..	58.9	7.27	182.3
May	..	..	..	58.0	8.74	205.5
June ..	..	..	..	55.9	4.77	221.3
July ..	..	..	..	55.2	3.13	207.9
August	..	..	..	54.6	5.08	182.5
September	..	..	..	55.7	1.26	242.5
October	..	..	..	57.3	1.05	232.8
November	..	..	..	56.8	4.05	203.4
December	..	..	..	57.5	1.70	209.5
Mean				56.9	Total 43.95	2,596.5

(b) *Marindas (Grassland Station, Altitude 9,200 ft.)*

1957				Mean Temp.	Rainfall	Sunshine
				<i>°F.</i>	<i>in.</i>	<i>hrs.</i>
January	..	..	..	52.4	3.29	125.4
February	..	..	..	53.9	0.04	197.7
March	..	..	..	55.3	3.62	218.6
April	..	..	..	54.5	6.02	143.3
May ..	..	..	..	55.9	7.57	199.2
June ..	..	..	..	52.9	6.11	219.5
July ..	..	..	..	51.0	5.22	189.2
August	..	..	..	50.6	4.18	147.5
September	..	..	..	53.2	1.24	195.8
October	..	..	..	56.2	0.84	248.2
November	..	..	..	55.0	3.20	195.7
December	..	..	..	55.2	1.20	230.3
Mean				53.8	Total 42.53	2,310.4*

*incomplete.

(c) *Subukia (Altitude 7,000 ft.)*

1957				Mean Temp.	Rainfall	Sunshine
				<i>°F.</i>	<i>in.</i>	<i>hrs.</i>
January	..	..	..	62.7	1.19	252.8
February	..	..	..	64.1	0.00	230.0
March	..	..	..	63.5	3.14	238.6
April	..	..	..	63.1	10.30	196.4
May ..	..	..	..	63.9	8.98	201.2
June ..	..	..	..	60.3	3.87	208.9
July ..	..	..	..	60.3	2.22	216.9
August	..	..	..	60.0	6.38	223.9
September	..	..	..	60.6	2.13	227.8
October	..	..	..	57.4	0.60	221.3
November	..	..	..	61.1	2.13	171.8
December	..	..	..	62.1	5.03	216.3
Mean				61.6	Total 45.97	2,605.9

(d) Ol Joro Orok (Altitude 7,800 ft.)

1957				Mean Temp.	Rainfall	Sunshine
				<i>°F.</i>	<i>in.</i>	<i>hrs.</i>
January	..	..	..	58·4	5·18	186·0
February	..	..	..	57·0	0·33	159·3
March	..	..	..	58·4	1·42	157·9
April	..	..	..	59·0	7·32	153·7
May ..	..	..	..	58·5	5·26	162·1
June ..	..	..	..	56·8	3·29	146·5
July ..	..	..	..	56·0	2·65	135·3
August	..	..	..	55·9	5·12	147·4
September	..	..	..	55·1	0·39	194·6
October	..	..	..	57·4	1·35	123·8
November	..	..	..	57·4	4·67	109·0
December	..	..	..	55·9	2·68	126·0
Mean				57·2	Total 39·66	1,801·6

ANNUAL REPORT OF THE OFFICER IN CHARGE SISAL RESEARCH, 1957

Meteorological

RAINFALL AT THE SISAL RESEARCH STATION, THIKA

	1957	Average previous 16 years
January	4.61" in 10 days	1.02" in 2.8 days
February	0.87" in 3 days	1.15" in 2.5 days
March	1.65" in 9 days	3.24" in 7.1 days
April	6.36" in 16 days	8.92" in 15.6 days
May	10.10" in 18 days	4.29" in 10.7 days
June	1.12" in 8 days	0.98" in 4.5 days
July	0.03" in 2 days	0.53" in 3.4 days
August	0.13" in 2 days	0.72" in 4.8 days
September	0.32" in 3 days	0.71" in 3.4 days
October	2.12" in 5 days	1.76" in 5.0 days
November	6.70" in 16 days	5.47" in 14.4 days
December	1.79" in 8 days	3.31" in 9.3 days
Total	35.80" in 100 days	32.10" in 83.5 days

The average annual rainfall for the 17 years recording at the Station, 1941-1957, amounts to 32.32 in.

Apart from the exceptional rains in January, the rainfall was normal and growth of sisal and vegetation was well maintained during the year.

Sale of Fibre

The fibre produced at the station during 1957 amounted to 46,306 lb. line fibre, 1,006 lb. brushed tow and 3,195 lb. flume tow. It was sold locally and realized the sum of approximately £1,075, which was paid to the Kenya Sisal Board. The fibre obtained from the external trials is handed over to the estates where the trials are situated.

Investigational Work in Progress

Nursery Trials

NURSERY FERTILIZER AND IRRIGATION TRIAL

The trial, which was first planted at the usual nursery spacing of 2 ft. x 9 in. (29,040 plants per acre) on 10th November, 1956, has the object of ascertaining how much the growth of bulbils in a nursery can be increased within a year by applications of sisal waste, urea and water, singly and in various combinations.

The sisal waste was applied at the rate of 30 tons per acre just before planting the bulbils. Nitrogen, in the form of urea, at the rate of 50 lb. N per acre was applied three weeks after planting the bulbils and the application was not repeated; thus the effect of this single early application could be assessed after 12 months. No water was added for the first nine months, but during August three applications each of 1 in. and, in October, one application of 2 in. were given. It is clear from the results that these applications were given too late to have any effect.

The plants obtained after 12 months were all considered too small for replanting, and only sisal waste and N had significantly increased the weight of the plants. The main effect of sisal waste was to increase the weight from 1.68 lb. to 1.95 lb. per plant while the main effect of N was to increase the weight from 1.73 lb. to 1.91 lb.

The interactions between the three factors are as follows:—

MEAN WEIGHT OF PLANTS IN LB.

Control	Waste	N.	Waste + N.
1.58	1.87	1.80	2.04
Control	Waste	Water	Waste + Water
1.63	1.91	1.75	2.00
Control	N.	Water	N. + Water
1.70	1.84	1.75	1.99

The trial was replanted on 16th November, 1957, and will receive the same treatments in a different form during the second cycle. This was the only Nursery trial lifted during 1957.

Planting Material Trials

Full and detailed reports on the two trials in progress were given in the 1956 report and variations are not great enough to justify a repetition this year.

The average increase in leaf count per plant during the year in the Planting Method Trial amounted to two leaves only where nursery plants were used while the leaf count of the old suckers planting material increased by four and the young suckers by seven. The reason why these average yearly increases are so small is due to heavy poling. As many of the plants cease to produce leaves so the average falls.

There is now no difference between the average total leaf count of 223 leaves produced by nursery plants and old suckers but the young suckers have produced about 13 leaves more per plant. All leaves are counted after planting out in the field. The difference of 13 leaves does not mean that young suckers will product more leaves during their life-time. It means that they were not as advanced in leaf production when transplanted into the field, and have therefore, during the 8½ years, grown 13 leaves more than the bigger plants. These extra leaves have not, however, increased the tonnage of fibre per acre. Nursery plants and suckers have produced 5.33 tons and 5.26 tons respectively against the 5.18 tons for young suckers. The advantage of using bigger plants initially has been emphasized throughout the cycle by the fact that these yields have been obtained sooner.

With an average of about 30 per cent poling only in the Planting Material Trial, the variations mentioned last year are still apparent. Of the bigger plants, 42 per cent are now poling and have yielded 5.8 tons of unbrushed fibre, while the smallest transplants have produced 4.3 tons only at 22 per cent poling. As the aim is to get the highest yield in the shortest time, the advantage of using big planting material is, once again, clearly demonstrated.

The difference in yields resulting from the first cut being taken at various stages of plant development show that where the first cut was taken early, when only 80-90 leaves had grown on the plant, the number of leaves cut off per plant is now 147 and the tonnage of fibre is 5.4 tons per acre. When the first cut was delayed until 100-110 leaves or 120-130 leaves were grown, the number of leaves

cut off per plant has been reduced to 134 and 133 while the tonnage of fibre is 4.8 and 4.4 respectively. The implication at present would appear to be that the earliest cut is to be recommended, but that cannot be done till poling is more general as it is the later and longer leaves which will make the greatest difference to the total yield. This trial is seven years old and the differences should be clearer within the next two years.

Plant Management Trials

Five trials were planted in 1948-1949, the object being to study the effects of spacing and cutting treatments on growth rate and fibre yields in various parts of Kenya.

The trials were reported on in detail in last year's report and although the figures are different now the relationships between them have not altered appreciably during the year and will not do so till poling becomes more general during the next two years.

The effect of treatments on the various points under observation can be summarized as follows:—

Leaf Count.—The effect of the three-row spacings under observation have shown that the plants grow faster when the rows are only 11 ft. apart as compared to 14 ft. or 18 ft. + 3 ft. in double rows. This advantage is clearly due only to the greater distance between the plants in the row as the effect was noticeable long before the root systems met in the centre of the rows. The double row of 18 ft. + 3 ft. has not done as well as the 11 ft. spacing, although the distance between the plants in the row is an inch or two greater. But it is assumed, and borne out in later trials, that the double row would have done better, had a closer row-spacing of say 13 ft. been chosen instead of the 18 ft. This would have meant that the distance between the plants in the row would have been at least 10 in. further apart than in the 11-ft. row spacing, and might have influenced the plant growth to a great extent.

The effect of leaf count of the three different populations has been the same in all five trials, i.e. the rate of leaf production on the individual plants is slowed down as the plant population increases. This may, in practice, mean a year's delay before the first cut can be taken in high populations, but it also means a prolonged cycle with no reduction in the average return of fibre per year of the cycle and accordingly a possibility of spreading reclamation costs and redemption charges over a longer period.

The effect of taking a first cut after the plants have grown 100 leaves only after transplanting has been to increase the rate of leaf production compared with first cuts taken at leaf sequence number 125 and 150, but this remark should be noted in conjunction with the remarks on leaf length.

The intensity of the cuts taken, governed by the number of leaves left on the plants after each cut, does not appear to have an appreciable effect on the number of leaves grown per plant.

Leaf Length.—Row spacing has not significantly affected the length of leaves grown, although the 18 ft. + 3 ft. double row on Thika's red soil and on the Kampi ya Moto light soil has induced a slightly shorter leaf. Due to speedier growth per plant in the lowest population, the leaves reached a given length earlier than in the higher populations in all the five trials. However, when the leaf sequence numbers were compared, the differences in length were small in the first 125 and 150 leaves produced, after which the effect of cutting became more pronounced in the higher rather than in the lower populations, resulting in a shortening of the leaves.

The biggest effect on leaf length was induced by the first cut. When this was taken after an average of only 100 leaves had grown per plant, the increase in the leaves growing subsequently was greatly reduced. A reduction in the normal increase of leaf length was also observed after a first cut of leaf sequence numbers 125 and 150 but not to such an alarming extent. As leaf length is of paramount importance for efficient and economic sisal production a first cut taken too early must be discouraged.

Cutting intensity has caused a difference in the plants similar to the first cut but less pronounced. Where only ten leaves have been left after each cut the increase in the length of leaves grown subsequently has been less than when 20 and 30 leaves were left. All the trials are cut only once a year. Cutting at shorter intervals might increase these differences.

Leaves Cut off per Plant.—The number of leaves cut off per plant is closely related to the number of leaves grown. This is not as obvious as it may sound at first. All leaves under 2 ft. length are discarded, so it means that the growth of leaves up to 2 ft. in length was similar in all treatments.

Average Weight per Leaf Cut.—The average weight of the leaves cut has been affected very little by the row spacing but linear responses were obtained from the other treatments with the heaviest average weight per leaf being taken from the lowest population, the latest first cut and the most lenient cutting.

Yield of Fibre per Acre.—Having seen how the plants react to treatments in the field the next step is to see how fibre yields at the factory are affected.

The yields to date in tons of unbrushed fibre per acre can be seen in the following table:—

			Ruiru Black Cotton	Hoey's Bridge	Kampi ya Moto	Thika Red Soil	Kibwezi
Spacing—							
14 ft.	..	..	3.06	5.76	3.98	5.09	4.77
11 ft.	..	..	3.20	6.70	4.19	6.31	5.26
18 ft.+3 ft.	..	..	3.38	5.97	3.27	5.09	4.85
Population—							
1,200	..	..	3.15	5.46	3.28	4.92	4.27
1,600	..	..	3.10	6.44	4.02	5.78	4.95
2,000	..	..	3.40	6.53	4.15	5.80	5.67
1st cut at—							
100 leaves	..	..	3.85	6.02	3.92	5.64	5.18
125 leaves	..	..	3.15	5.94	4.02	5.63	5.15
150 leaves	..	..	2.65	6.47	3.51	5.23	4.56
Cut leaving—							
30 leaves	..	..	3.32	6.42	3.88	5.50	5.30
20 leaves	..	..	3.22	6.36	3.73	5.39	4.84
10 leaves	..	..	3.10	5.65	3.84	5.61	4.74
Mean	..	..	3.22	6.14	3.82	5.50	4.96
Difference required for significance—							
P=0.05	..	..	0.65	0.41	0.41	0.37	0.38
P=0.01	..	..	0.88	0.55	0.55	0.50	0.51

It is noticeable that in all cases, with the exception of the trial on black cotton soil, a greater yield has been obtained from the closer row spacing, which in turn means a wider spacing of plants in the row.

The yield increase relating to population increase is becoming apparent and should be even more pronounced in the coming years as poling is accelerated. In the low population treatment the poling at present is about 80-85 per cent in all trials while the poling percentage in the 1,600 plant/acre population ranges from 45 in the slow-growing trial on black cotton soil to 55 at Hoey's Bridge and Thika while at Kampi ya Moto and Kibwezi it is about 80.

Where the population is increased to 2,000 plants/acre the poling percentages have reached between 25 and 40 only except at Kibwezi where it is 70. These comparatively low figures indicate that there is still a fair complement of leaves left in the fields for future fibre production. The gap therefore between the figures for fibre yields will widen even more in the coming years.

With the exception of the trial at Hoey's Bridge, the indications are that a first cut taken at leaf sequence number 150 is too late. The number of leaves over 2 ft. in length lost due to drying-up in this late cut was noticeable in all trials, but less so in the trial at Hoey's Bridge where drying-up appears to take place at a slower rate. The average number of leaves of over 2 ft. length lost per plant by delaying the first cut to the 150-leaf stage was about 20 on the Ruiru black cotton and Thika red soil, and about 27 at Kibwezi, so that there is a good indication that the first cut should be taken earlier at around the 125-leaf stage to prevent this loss of leaf. At Kampi ya Moto the loss per plant was only about five leaves while it was less than one leaf per plant at Hoey's Bridge. The early first cut has in all trials retarded poling. The late first cut has, however, generally needed a smaller number of leaves per ton of fibre produced. These aspects of the trials need further study at the end of the cycles.

The effect on fibre yields of the intensity of cut has been most noticeable at Hoey's Bridge and Kibwezi where the lenient cuts have produced significantly more fibre. In all the trials there is a linear effect on poling and on the average weight of leaves cut with the most lenient cut giving the highest poling percentage and the heaviest leaf. This in turn is reflected in the smaller number of leaves needed per ton of fibre.

A summary of the results as they appear to date would indicate that wherever the sisal plant grows one should aim at wide spacing between the plants in the row, even though this means reducing the distance between the rows. However, the distance between rows is itself governed by the space needed for tractor operations and the space for cutters to work in comfort. High plant populations per acre should be aimed at for greater yields per acre. The first cut should take place when approximately 125 leaves have grown on the plants after transplanting, and not before, except that it may be delayed in the Hoey's Bridge area without too great a loss, and should be taken earlier in the Kibwezi area to avoid a loss of leaves over 2 ft. in length. The intensity of the cuts should always be governed by the number of leaves left on the plant and not by the number of leaves removed from the plant. At least 30 leaves should be left on the plants after each cut, except that a slightly heavier cut at Kibwezi does not appear to affect the plants to any great extent.

In another trial comparing double versus single row with three different plant populations and two different row spacings all the plants have now had the first cut. The plots were cut individually when the plants had, on an average, grown 125 ± 5 leaves since planting. Some of the treatments have had three while others have only had one cut.

The latest cuts were taken on high populations in the single lines.

The results can be summarized as follows:—

	POPULATION PER ACRE			ROW SPACING		LINES	
	1,600	2,000	2,400	11 ft.	13 ft.	Double	Single
Leaf Count	177	163	152	168	161	170	158
Length of last leaf ..	44 in.	47 in.	49 in.	46 in.	47 in.	45 in.	48 in.
No. of leaves cut ..	88	63	53	72	65	75	62
Tons fibre per acre ..	2.04	1.76	1.73	2.02	1.68	2.08	1.61

The speedier growth due to low population as well as in the double compared to the single row is shown to be greater than the variation due to row spacing, and is reflected in the number of leaves grown per plant and in the fibre yields. The trial is only $5\frac{3}{4}$ years old and more information is needed before a detailed report on fibre yields can be made.

Cultivation Trials

In the first cultivation trial planted in November, 1950, the object is to observe the effect of six different cultural treatments on plants which had been planted both on the flat and on ridges. The trial was intentionally planted on land of a high fertility and great variations are not expected in the first cycle but may be expected after the cultural treatments have had a chance to alter the structure of the soil. The effect of ridging on this red soil has been small and amounts to only two leaves more per plant over the average of 225 leaves per plant on the flat-planted sisal.

The growth rate expressed in the number of leaves per plant and the fibre yields obtained to date can be expressed as follows:—

	Leaf Count per plant	Tons of fibre per acre
1. Permanent grass strips kept low	220	7.17
2. Permanent grass strips cut periodically and grass used as mulch round plants	223	6.34
3. Clean weeded by frequent discing for three years thereafter as (2)	224	6.83
4. Clean weeded by frequent discing for three years then discing twice a year	237	7.05
5. Discing twice a year	226	7.01
6. Clean weeding by frequent discing	226	7.73

The clean weeded plants have, on an average, grown only about eight leaves more per plant than those in the areas with grass. Poling is becoming general in this trial and, at present, amounts to about 45 per cent of the plants.

It is unlikely that the variations will become more pronounced in the first cycle, but very likely that they will do so in future cycles.

A trial planted in September, 1956, on camber beds on black cotton soil in Ruiru, was interplanted with pineapples. The average growth figures per plant after 14 months are as follows:—

	Leaf Count	Length of last leaf
		<i>in.</i>
Sisal alone	45	27
Sisal + Pineapples	44	27
Sisal + Sulphate of ammonia	45	27
Sisal + Pineapple + Sulphate of ammonia ..	45	28

The sisal is growing very well but variations can be seen in the pineapples and these will be elucidated when the harvest commences in 1958. The intention is to remove all pineapples after the first ratoon crop, which should be complete before the first cut is taken on the sisal plants.

Fertilizer Trials

There have been no great changes in the fertilizer trials during the year. The first trial of this nature planted in March, 1950, has reached an average of 45 per cent poling and should be completed within the next two years. The increased rate of growth where sisal waste has been applied has become apparent but, and this has been stated in previous reports, it is doubtful if the application of sisal waste will actually induce the plants to produce a greater number of leaves. In October, 1956, the plants receiving sisal waste had, on an average, grown 213 leaves while those without sisal waste had grown 20 less per plant.

The poling percentage for the waste plots is now 77 against only 18 in the plots not receiving waste and, with these plots still producing leaves whilst a large proportion of the plants receiving sisal waste are ceasing to produce, the difference in leaf count in October, 1957, is only 225 against 209. It is expected that the plants treated with sisal waste will pole out within a year while the untreated ones will continue to grow leaves for some time to come so that the total leaf number may well be the same in the end.

The application of sisal waste has, however, consistently induced the growth of a longer leaf and in all recordings during the life of the plants the leaves in the sisal waste plots have been 3 in. to 5 in. longer than those in the untreated plots. This difference in length may explain the difference in the tonnage of fibre obtained, and the consistently lower leaf numbers needed per ton of fibre.

The trial is only 6½ years old and, with a population of 1,980 plants per acre, the tonnage of unbrushed fibre now amounts to just under 5¼ tons in the sisal waste plots against 3.4 tons in the untreated plots. It seems clear already, when poling is still incomplete, that the average yield per acre per year of the cycle in the waste plots is going to be well above that of the untreated plots.

When comparing the length of leaves in the sequence of their appearance or growth on the plant it is seen that within the first two years the plants treated with sisal waste produced considerably longer leaf than those not being treated, and the plants have maintained their superiority during the whole cycle. As an example, there can be quoted leaf sequence number 125 which, in the waste plots, was recorded in January, 1953, and was 107 cm. long. In the plots not treated with waste, leaf sequence number 125 was not recorded before July, 1953, and

was only 101 cm. long. Other examples which demonstrate the speedier growth and longer leaves resulting from the application of waste are as follows:—

With waste

April, 1955 LSN 185 108 cm. long

April, 1956 LSN 205 102 cm. long

Without waste

April, 1956 LSN 185 95 cm. long

July, 1957 LSN 207 94 cm. long

A similar feature is apparent where nitrogen applications were made, but to a smaller degree. A few examples will suffice:—

With N.

July, 1953 LSN 135 107 cm. long

July, 1954 LSN 164 109 cm. long

July, 1955 LSN 188 106 cm. long

January, 1957 LSN 213 99 cm. long

Without N.

October, 1953 LSN 136 105 cm.

January, 1955 LSN 165 100 cm.

April, 1956 LSN 189 96 cm.

October, 1957 LSN 211 89 cm.

The results reflected in the yield of fibre per acre were 3.9 tons without N and 4.7 tons with N or an increase of 0.8 tons per acre.

The interaction between sisal waste and N can be expressed as follows in tons of fibre per acre:—

No N. and no Waste

2.87

N.

3.89

Waste

4.87

Waste + N.

5.52

Applications of lime, phosphate and potash have not increased the yields of fibre to any significant extent in this trial.

A series of fertilizer trials were planted in the second half of 1953 and the first half of 1954 in various parts of the country. Here again, the greatest responses have been to applications of sisal waste, at various rates, and to nitrogen. A comparison of the results of the average number of leaves grown per plant appears as follows:—

	SISAL WASTE TONS PER ACRE					NITROGEN	
	No waste	12½ tons	25 tons	50 tons	100 tons	— tons	+
Kibwezi after 4½ years ..	148	—	159	165	169	156	164
Kitale after 4¼ years ..	101	—	102	108	112	102	109
Voi after 3½ years ..	57	59	60	68	—	60	62
Ruiru murrum after 3½ years ..	87	90	93	99	—	86	99
Lomolo after 3½ years ..	99	99	103	109	—	94	111

The extremely slow growth at Voi is mainly due to the very low rainfall during the first two years of growth.

Repeat-applications of sisal waste have been made in some of the trials during 1957 but there is, as yet, no noticeable response to these.

The initial responses to 12½ tons of sisal waste per acre have been so small as to be hardly worth while and 25 tons of waste would appear to be profitable only at Kibwezi. Only when at least 50 tons of waste were applied initially was a substantially greater number of leaves produced per plant. It may be worth keeping in mind that all these trials are planted 13 ft. × 3 ft. × 2 ft. 9 in., giving a population of 1,980 plants per acre so that ten leaves more per plant is nearly 20,000 leaves more per acre. This in terms of tonnage should mean an additional 0.25 tons per acre at least.

The responses to lime and phosphate have in all cases been small as far as leaf growth is concerned. Their effect on fibre yield, if any, will be studied when harvesting commences.

The only trial in this series which has been cut so far is the one at Kibwezi where the fibre yields obtained are as follows:—

	No Sisal Waste	25 tons	50 tons	100 tons	Mean
No Nitrogen	1.08	1.56	1.98	2.33	1.74
Nitrogen	1.27	1.97	2.43	2.67	2.08
Mean	1.18	1.77	2.20	2.50	

Some of the plots have had one and some two cuts so these figures can only indicate the trend of the first cuts.

Two of the fertilizer trials planted in December, 1952, on the Thika red soils are growing on land which has been under sisal for two cycles and was originally planted to sisal in 1925. The treatments imposed on these trials cover sisal waste, N, P and Ca in the presence and absence of an introduced grass cover. The response to sisal waste has been an increase in the number of leaves grown per plant from 130 to 142. The responses to the other fertilizers have been small and insignificant, with the exception of N, which in one of these trials stimulated the growth and increased the leaf count from 128 to 132 per plant. The biggest response was obtained from the introduced molasses grass (*Melinis minutiflora*) which retarded the growth of the plants so that the leaf counts at present are 14 to 16 leaves behind those of plants where no grass was introduced. No valid comparisons of fibre yields are yet possible.

It is possible that the results would be different had a grass which is less vigorous been planted, or had the grass been controlled better by mowing or grazing in the early stages. The fertilizers were unable to compensate for the depressing effect of the grass. It is worth remembering that the competition became noticeable only after the plants had been in the ground for two years. A strip 2 ft. wide on either side of the sisal plants was kept hand-cleaned. The roots had not developed and extended into the strip of grass between the lines, so that the competition for nutrients and moisture was not apparent during the first two years.

An observation trial in crude sand-cultures was abandoned in December after one year. The effect of withholding different nutrients clearly showed up in the appearance of the plants. A comparison was made between the number of leaves grown per plant during the year. Where complete nutrient application was made, the number of leaves was 35 and this was about the same as in those applications which were minus K and minus Ca. The absence of S and P from the solution reduced the leaf count by about 6-7 while the absence of Mg reduced the leaf count by about 13. In the absence of N the plant produced no more than the 15 leaves grown on the plants living on water only.

A new fertilizer trial was planted in March, 1957, at Donyo Sabouk on a heavy clay soil. The treatments cover sisal waste applications at planting and after 18 and 36 months, each application being at the rate of 50 tons per acre. Gypsum, at 2 tons per acre, was applied before planting and also to be included is an N application after 18 months.

Hybrids and Variety Trials

The promising hybrids being compared with sisal have all produced a considerably greater number of leaves, but these have all been considerably shorter. As a cut on common sisal has a tendency to reduce the natural increase in leaf length it was felt that a period longer than an annual cutting cycle may be more suited to the hybrids so that a 15 months cutting cycle has been chosen. For this reason no cutting took place in this trial during 1957.

The increase in the number of leaves followed the expected behaviour of hybrids in producing more but shorter leaves than common sisal. Some of the hybrids were poling during the year and a pole cut was taken. There are indications that some of these hybrids may produce more fibre per acre than sisal but amongst the eight hybrids under observation the leaves are so short that a considerably greater number will be needed per ton of fibre produced.

Herbicide Trials

Work on chemical weed control was continued during the year and promising results have been obtained with dalapon for the control of grasses including couch. The first two large-scale trials, each of five acres, were treated during the year with promising but not entirely satisfactory results, due partly to the low application of only 10 lb. dalapon but mainly to the unevenness of the couch growth. Where there was little couch there was satisfactory control, but where couch rhizomes had been raked into concentrations the control was unsatisfactory and repeat-applications were needed, the results of which are not clear yet.

Herbicidal trials for the control of broad-leaved weeds in sisal have given very promising results. A couch infested area, which in March and September, 1957, had been treated with 10 lb. and 5 lb. dalapon per acre respectively was planted to sisal in October. Broad-leaved weeds appeared in November and on the 27th of that month six different herbicides were applied, all at a rate of 1 lb. acid equivalent per acre.

Scoring for grasses and broad-leaved weeds, using 0 for complete absence and 10 for complete cover, gave the following comparisons at the end of the year:—

	No treatment	MPCA.	MCPB.	2,4-DE	2,4-DA	Simazin	2,4-DB
Grass	1.7	4.7	2.0	8.7	7.3	1.3	3.0
Broad-leaved Weeds ..	9.3	5.3	8.0	0.7	1.0	9.0	8.0

With weed-growing up through the grass it is possible to have a complete cover of more than 10.

The grasses were mainly *Rhynchelytrum repens* but other annuals were noted. The control of couch was excellent. It is noticeable that where the greatest control of broad-leaved weeds was achieved there is now the greatest cover of grasses, and vice versa. The main object of this trial was the control of broad-leaved weeds which has been most effectively achieved with 2,4-D Ester and 2,4-D Amine.

A nursery trial with 2,4-D Ester and Amine, and MCPA showed similar results and the variations between them, at differing rates (from 0.75 lb. to 1.5 lb. acid equivalent per acre) were small after two months. There are no noticeable effects on the bulbils at present.

Half of the area was sprayed with dalapon before planting the bulbils. Scoring for grass and broad-leafed weed growth is as follows, using the same standards as above.

SUMMARY FOR DALAPON

				Grass cover	Broad-leafed weeds
With Dalapon	..	..		2.5	2.9
Without Dalapon	..	..		7.9	1.5

Most of the grasses in the plots receiving dalapon are annuals, while there is a substantial couch cover (*Digitaria scalarum*) in the plots without the dalapon treatment.

The effect of the broad-leafed weedkillers at two levels is as follows:—

	Control	2,4D AMINE		2,4D ESTER		MCPA	
		high	low	high	low	high	low
Grasses:							
+ Dalapon ..	1.8	3.5	2.0	2.5	4.5	2.0	2.0
— Dalapon ..	8.8	7.5	6.5	8.0	7.0	8.5	8.5
Broad-leafed Weeds:							
+ Dalapon ..	6.3	1.5	1.5	1.0	1.0	2.5	3.0
— Dalapon ..	2.3	2.0	2.5	0.5	1.5	1.0	1.5

The control of grasses in dalapon plots is noticeable. The other herbicides used have had no effect on the grasses nor are they expected to have any. The best control of broad-leafed weeds has been obtained from 2,4-D Ester. The increase of broad-leafed weeds in areas where grasses are controlled has been demonstrated and indicates the need to experiment with mixtures. This is on the programme for the coming year.

Observation plots were sprayed in April, 1957, with dalapon at 20 lb. per acre and various grasses were sown a fortnight later and again at fortnightly intervals to ascertain the periods needed between spraying with dalapon and the sowing of selected grasses. All six grasses sown after the first fortnight germinated in the beginning of June and appear unaffected by the herbicide.

Cover Crops and Grasses

During the year, 12 areas, each of one-fifteenth of an acre, were sown to grass to see if a satisfactory grass could be found for sowing between sisal lines at the time of planting. The aim is to get a grass which is easily controlled, drought resistant and palatable to cattle.

Similar observations are carried out on about 20 cover crops, and when the most promising have been selected it is the intention to compare them in the field and observe any differences in their competition with sisal for nutrients and moisture.

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ANNUAL REPORT FOR IRRIGATION INVESTIGATIONS, 1957

HOLA

Land use studies were continued at Hola. These covered crop observations and land reclamation investigations.

CROP OBSERVATIONS

The 1956 investigations having demonstrated that a variety of crops can be grown on the saline/alkaline soils of the desert hinterland without prior reclamation treatment, increased attention was paid to observations on the growing of a variety of crops under normal irrigation. The following table summarizes the results obtained (all yield figures should be taken as indicative only):—

CROP	YIELD RECORD, LB. PER ACRE		
	High	Mean	Low
Bulrush Millet	2,495	2,170	1,832
Maize	2,074	981	363
Popcorn	871	744	616
Rice	4,960	2,599	1,625
Sorghum	2,475	1,499	522
Finger Millet	1,768	929	555
Cowpea	1,210	447	48
Green Gram	414	357	300
Groundnuts	2,420	1,180	323
Pigeon Pea	1,965	1,789	1,613
Soya Bean	640	608	575
Velvet Bean	1,258	1,099	940
Castor	—	305	—
Cotton	2,891	1,858	574
Hibiscus	—	25,000	—
Jute	—	(green matter) 520	—
Sunflower	—	(fibre) 1,634	—
Sweet Potato	7,681	6,568	5,302

Observations were undertaken on a red soil and on a heavier grey soil which represent the extremes of the soils likely to be used in initial development at Hola. Generally the crops have not behaved consistently better on the one than on the other. Initially, however, the red soils have proved the more receptive of water and the more easily worked and so project development in the first instance is being undertaken on these and they have received the most attention

The green strip of the Tana River flood plain has provided a source of infestation for the experimental areas of a great variety of plant pests, diseases, and vermin and the continuity of cropping which was necessary initially has provided abundant opportunity for these infestations to build up. The consequence has been that the grain crops, and the cotton particularly, have been smitten again and again and even intensive control sprayings have done no more than keep the afflictions of these crops at bay. The success of the crop and a large part of the wide variation in yields recorded is determined by the intensity with which it was attacked during growth. The best results to date have been from April plantings and the early practice of continuous planting has now given way to seasonal plantings at the start of each rainy season. However, more than simple crop debilitation is involved for, in many instances, crops which had grown with vigour came to nothing at harvest. The closer observation during growth which arrangements now made for experimental work at Hola will make possible should help throw light on the causes of such harvest disappointments.

Among the observations a fertilizer trial involving the application to the seed-bed of 1 cwt. double supers and to the established crop of 1 cwt. muriate of potash and 2 cwt. sulphate of ammonia per acre was included. The effect has been variable and seems beneficial only with cereals:—

CROP	YIELD LB. PER ACRE	
	Fertilized	Unfertilized
Bulrush Millet	2,289	2,043
Maize	155	1,217
Rice	2,886	2,448
Groundnuts	1,200	1,378
Cowpea	410	533
Cotton	974	909

While the results justify further fertilizer investigation, it is apparent that the benefits to be derived from fertilizer usage on this new land will not be dramatically large.

Maize and cotton, though capable of yielding satisfactorily, often showed signs of waterlogging or nitrogen shortage. The varieties of cowpeas tested tended to go to leaf rather than to seed. Velvet bean was variable, sometimes doing well and sometimes badly. Chillies made slow growth and were yellowed. Lucerne, soya bean, sweet potato, cassava and tomatoes did well. Egyptian clover took well but made poor growth and ultimately failed. Green gram performed indifferently. Other crops tested include bananas, cantaloup and water melons, *Ensete Edulis*, Napier grass, onions, simsim and sugar cane.

Initial observations on rice and cotton varieties (including long staple cottons) were started and quite big differences in harvest yields are being obtained.

LAND RECLAMATION

With the aim of reducing soil salinity and alkalinity, crops are being tried on ridges, low raised beds and on cambered beds similar to those which are being used successfully for cropping wet land in the Kenya Highlands. Additionally, a number of gypsum and leaching treatments preceding planting have been tried.

The following summarizes the yields obtained with these various cultural treatments:—

TREATMENT	YIELD LB. PER ACRE					
	Maize	Bulrush Millet	Rice	Cowpea	Ground-nuts	Cotton
Flat cultivation	889	2,154	2,762	442	985	1,360
Flat cultivation leached ..	1,544	2,164	2,464	399	1,574	1,167
Flat cultivation leached with 2 tons gypsum ..	1,510	2,181	2,775	505	1,309	1,283
Flat cultivation leached with 7 tons gypsum ..	918	—	—	—	—	—
Flat cultivation leached with 20 tons gypsum ..	868	—	—	—	—	—
3 ft. Ridge	1,295	—	—	567	—	1,027
6 ft. Bed	1,065	—	—	584	—	1,323
6 ft. Bed with 2 tons gypsum	1,088	—	—	—	—	—
6 ft. Bed with 2 tons gypsum and leaching ..	479	—	—	48	—	—
Cambered bed	1,050	—	—	699	—	1,430
Cambered bed with leaching	691	—	—	97	—	—
Cambered bed with leaching and 2 tons gypsum ..	389	—	—	159	—	—

Except with cotton, the ridging and bed cultivations by themselves showed distinct improvements in yield over flat cultivation. Neither gypsum application nor leaching on the flat before planting had much consistent effect on crop yields. On the other hand, when the land was set up in beds, leaching seems to have been distinctly harmful. Crop observations indicate that leaching leads to a shortage of available soil nitrogen which will need adjusting before the benefits of leaching find expression.

The initial leaching studies on the red soil were followed by investigation of the desirable duration of leaching and of rates of gypsum application. Leaching of this soil proved possible without special prior treatment, but on the heavier grey soil an initial flooding followed by draining and drying out, preferably with the growing and incorporation of a green manure crop, was found necessary for securing water penetration.

LABORATORY INVESTIGATIONS

Elaborate laboratory studies have been undertaken in connexion with the field investigations. These have aimed to study the changes in salinity and alkalinity in Hola soils which take place during reclamation, to determine the probable effect on the surface soil of establishing a water table in the soil during irrigation and to establish the causes of poor growth where this occurs. The special requirements of the grey soil lengthened the time it took for its leaching, the consequence being that material was not available from this soil and the 1957 laboratory studies were confined to the red soil.

The following table is illustrative of the changes in salinity and alkalinity which took place during leaching:—

TREATMENT DETAILS	HORIZONS						
	0-6"	6-12"	12-24"	24-36"	36-48"	48-60"	60-72"
			<i>E.C. Mmho/cm.</i>				
Before leaching	4.0	9.5	17.0	21.5	19.3	15.7	16.4
Straight after single flooding ..	2.5	1.6	2.0	13.6	25.1	25.0	20.9
Straight after 6 weeks flooding ..	3.0	2.0	1.5	8.3	13.7	19.6	21.1
10 weeks after 6 weeks flooding ..	1.0	2.5	1.2	3.2	8.4	12.9	20.9
10 weeks after 6 weeks flooding, with 20 tons gypsum	3.5	4.7	2.3	6.8	8.6	2.1	13.0
			<i>Soluble Sodium m.e. %</i>				
Before leaching	1.0	3.7	4.4	9.0	8.8	8.9	9.1
Straight after single flooding ..	0.5	0.6	1.3	8.4	12.9	17.8	12.6
Straight after 6 weeks flooding ..	1.0	0.9	0.9	7.4	9.6	15.4	16.0
10 weeks after 6 weeks flooding ..	0.8	0.5	0.8	2.2	14.0	13.9	14.5
10 weeks after 6 weeks flooding with 20 tons gypsum	0.5	1.4	0.8	5.2	7.0	8.7	10.3
			<i>Exchangeable Sodium m.e. %</i>				
Before leaching	6.6	5.7	12.5	12.9	15.0	16.8	18.1
Straight after 6 weeks flooding ..	0.8	3.8	10.5	7.3	10.8	12.2	20.4
10 weeks after 6 weeks flooding ..	0.6	3.8	6.6	8.0	0	8.2	10.1
10 weeks after 6 weeks flooding with 7 tons gypsum	0.4	1.4	6.1	3.5	0	6.5	1.7

The data demonstrates the great reduction of soluble salts and of soluble sodium which took place during leaching. A single flooding was sufficient to effect immediate improvements down to a depth of 3 ft. with sufficient improvement to a depth of 2 ft. for most crops to root satisfactorily. The six weeks' flooding carried the immediate improvement to a depth of 4 ft. and extended the satisfactory rooting zone to a depth of 3 ft. Still further improvements took place as the soil drained out after leaching and, in ten weeks, benefits had become apparent to a depth of 5 ft. and soil salinity (as determined by equivalent conductivity—E.C.) had fallen to a safe level to a depth of 4 ft. Improvements in the soluble sodium situation during drainage were confined to the top 3 ft. Gypsum application of as much as 20 tons per acre seems not to have brought about any important benefits to the salinity situation.

The effect of leaching on exchangeable sodium needed a period of drainage to become apparent. A general lowering of alkalinity status to safe levels then appeared to take place even after a single flooding. The reduction of alkalinity went still further when applications even of seven tons of gypsum per acre were given before leaching.

A marked variation from soil to soil was apparent particularly in the sub-soils of the leached land, indicating considerable point to point variation in salinity and alkalinity status after reclamation.

In the water table study the effect was studied under field conditions of water tables maintained at various depths below ground level on the moisture content, salinity and soluble sodium distribution in the surface soil. The results obtained are summarized:—

COMPONENT												
HORIZON SAMPLED	Moisture %				E.C. Mmho/cm.				Soluble Sodium m.e. %			
	Depth to Water Table											
	2 ft.	3 ft.	4 ft.	Over 18 ft.	2 ft.	3 ft.	4 ft.	Over 18 ft.	2 ft.	3 ft.	4 ft.	
0-6 in. ..	8.9	10.1	8.5	1.5	3.1	4.5	5.9	0.5	0.8	1.7	1.2	
6-12 in. ..	20.6	13.8	11.5	2.6	41.4	15.1	18.6	1.1	13.9	6.4	5.0	
12-18 in. ..	24.5	23.2	12.6	8.6	34.7	33.3	26.9	5.3	16.8	14.6	8.6	
18-24 in. ..	28.4	27.1	17.7	14.9	15.2	23.6	31.1	8.1	12.5	11.9	14.6	
24-30 in. ..	34.5	35.4	27.1	19.6	6.7	4.7	28.9	17.8	6.5	2.5	15.2	
30-36 in. ..	38.3	38.1	31.9	22.7	4.7	7.0	12.4	17.4	2.2	5.1	11.2	
36-42 in. ..	31.1	37.8	33.9	23.7	4.4	3.8	10.1	17.8	2.2	1.6	7.1	
42-48 in. ..	38.0	35.9	35.3	25.2	6.2	7.1	9.5	19.9	6.0	6.8	7.8	
4-6 ft. ..	34.4	34.7	34.1	17.8	13.6	6.8	6.4	17.5	16.9	6.1	7.1	
6-11 ft. ..	26.5	24.9	—	—	22.9	14.7	—	—	15.7	12.9	—	

A sharply defined wet front was maintained in the soil some height above the water-table surface, the thickness of the wetted zone being 24-27 in. where the water-table was at 4 ft., falling to about 18 in. where the water-table was raised to 2 ft. from ground level. Straddling this wet front was a zone into which moved and accumulated salts from the wetted soil below. This zone became increasingly sharply defined and the salt concentration in it became greater as the water-table was raised towards the soil surface. At all water-table levels, the salt in the accumulation zone attained concentrations which are regarded as lethal to farm crops. The positions of the water front and of the salt and sodium accumulation zones are indicated by the data in italics in the summary table.

Laboratory investigations of the poor growth situations emphasized the importance of nitrogen on desert soils at Hola, particularly after reclamation. Thus the dry matter of leaves of vigorous cotton on plot borders attained an average of 3.70 per cent N, the cotton from inside the best plots an average of 3.4 per cent N, and the cotton from the inside plots where growth was restricted, yellowed, or spindly, an average of 3.13 per cent N. Low leaf nitrogen figures (with an average of 2.91 per cent) went with long leaching while a single flooding before planting was sufficient to bring leaf content down from an average of 3.50 per cent (not flooded) to 3.37 per cent (flooded).

The 1957 investigations point to successful crop production on the saline/alkaline desert soils at Hola being possible even without prior reclamation. However, the reduction in salinity and sodium content which results from leaching represents an improvement in soil condition which, if lasting, should be worth

attaining. At the same time, crops grown on leached land have behaved disappointingly and, as nitrogen deficiency seems an important factor involved in this, land reclamation investigations need extending to cover fertilizer requirements. The investigations also have indicated that it is essential to maintain the water-table deep enough for the salt concentration zone which it will induce between irrigations not to develop so close to the soil surface that crop roots will be affected. Watch will need to be kept on any tendency towards water-table establishment when irrigation develops at Hola, and for this purpose piezometer tubes will need to be installed in the major irrigation areas as they are brought under crop.

E. BELLIS,
Senior Soil Chemist.

Irrigation Research Station, Mwea/Tebere**WEATHER CONDITIONS**

Rainfall for the year totalled 41.91 in. This was the first year in which records were kept at the Irrigation Research Station although recording had been done during 1955 and 1956 at the Chief Richard experimental plots, some four miles west of the station. The monthly and annual totals for 1957 are shown below.

				1957
January	..	..	..	5.30
February	..	..	..	0.61
March	..	..	..	1.95
April	..	..	..	12.54
May	..	..	..	9.17
June	..	..	..	0.56
July	..	..	..	0.34
August	..	..	..	0.09
September	..	..	..	0.69
October	..	..	..	1.66
November	..	..	..	7.84
December	..	..	..	1.16
Total	..	..	..	41.91

*Variety Trials***RICE**

A variety collection was started in 1956 with the object of finding good varieties for direct use in Kenya. Varieties were obtained from various countries including Tanganyika, Sierra Leone, Malaya and Ceylon. In 1957, the number of varieties was reduced from 90 to 66 by the discarding of all those with a red seed coat as these are practically unsaleable in Kenya. Each variety was grown in a three-row plot and records taken of height, tillering, life period, yield and grain shape. Twenty heads were selected in the centre row of each variety to act as seed for next season's sowing, but with some varieties severe stem borer damage necessitated taking heads from all three rows.

A variety trial of ten promising varieties was also done, the design being a latin square with plot size $1/436$ acre so that the trial could be accommodated in a single $\frac{1}{4}$ -acre field. The trial was, unfortunately, planted rather late, which resulted in the yields of most of the varieties being greatly reduced by stem borer attack. The best yield was given by Siam 29, a very late ($7\frac{1}{2}$ months) variety from Malaya. This variety has a good quality grain and is worthy of further trial as a possible long-season variety. The present commercial variety Sindano, however, normally yields very well if planted early in the long rains, as it then matures before serious stem borer damage has been done. Sindano has a high quality grain which was confirmed by a very satisfactory report on a two-ton sample sent for a milling test to Dar es Salaam. As Sindano has thoroughly proved itself over many years in various parts of Kenya, it should continue as the commercial variety at Mwea/Tebere until more research has been done on other varieties.

Seed Dormancy and Duration of Viability

An investigation into the dormancy period and the duration of viability of rice seed was started late in 1956 and continued throughout 1957. The object is to find out, by means of a germination test every ten days how soon after

harvest, rice seed can be safely sown and for how long it can be stored before losing its viability. The varieties being tested are Sindano and Pishori. Both varieties reached full germination capacity about six weeks after harvest and at the time of writing, 17 months after harvest, have not yet started to decline in viability.

Fertilizers and Spacing Trials

A three-cubed fertilizer trial was started in the long rains on the variety Sindano to test the effect on yield of sulphate of ammonia, double superphosphate and muriate of potash, each at three rates of application. Only one replicate of 27 plots was used with plot size approximately 1/40th acre. All the fertilizers were applied broadcast just before transplanting. Double superphosphate at 75 lb. per acre caused a significant yield increase of 1,300 lb. of grain per acre, but there was only a small additional increase from the 150 lb. rate, which was not significant. There was no response to either sulphate of ammonia or muriate of potash. Mean yield was 3,200 lb. of grain per acre.

An identical experiment carried out on the rich Nguka Swamp soil showed no response to any of the three fertilizers. Mean yield in this trial was 4,060 lb. of grain per acre.

A randomized block experiment began in the long rains on Sindano to compare various times of application of sulphate of ammonia. Plot size was approximately 1/20th acre. Work in some countries has shown that rice often responds better to this fertilizer when it is applied some weeks after transplanting or as split applications at various times. The times of application used in this experiment were:—

- (a) Just before transplanting.
- (b) Three weeks after transplanting (maximum tillering stage).
- (c) Nine weeks after transplanting (flower primordial initiation).
- (d) Application split equally between the above three times.
- (e) Nil.

The rate of application was 2 cwt. per acre. There was, however, no response to sulphate of ammonia in any of the treatments.

A factorial spacing trial was started in the long rains to compare three different spacings of rice, three numbers of seedlings per clump and three rates of sulphate of ammonia. The spacings were 6 in. × 6 in., 9 in. × 9 in. and 12 in. × 12 in. The numbers of seedlings per clump were 1, 2 and 3 and the sulphate of ammonia rates were nil, 1 cwt. and 2 cwt. per acre applied just before transplanting. The 9-in. spacing gave a highly significant yield increase over the 12-in., but the small extra increase from 6-in spacing was not significant. Yield was not significantly affected by number of seedlings per clump or by sulphate of ammonia and there were no significant interactions.

Stem Borer Trial

This trial was done on the variety Sindano in the long rains, in co-operation with the Entomology Section, to obtain preliminary information on the Rice Stem Borer, *Rhinaphe vectiferella*, its control, and the extent to which it is responsible for empty grains. The latter can sometimes cause considerable loss of crop in the Mwea/Tebera area. The treatments, which were combined factorially in three blocks of 12 plots each were:—

- (a) Endrin sprayed three times on the 21st, 33rd and 45th days after transplanting at the rate of 1 fluid oz. of 19.5 per cent liquid in three gallons per 1/64th-acre plot.
- (b) 5 per cent B.H.C. dust applied twice to the nursery.

- (c) Sulphate of ammonia applied to the nursery at three different rates: nil, 2 cwt. per acre and 4 cwt. per acre.

There was no significant effect on rice yield of any of the treatments. A count of number of larvae and empty heads was done on two sample plants from each plot ten days before harvest. The endrin treatment produced a significant reduction in the number of larvae per plant from 14 to nine and possibly a reduction in the percentage of empty heads but this was not quite significant. There was no effect of the B.H.C. or sulphate of ammonia treatments. As the number of plants sampled was very small these results should be treated with reserve.

HIBISCUS CANNABINUS

Fertilizer Trial

A three-cubed factorial fertilizer trial was done on irrigated *Hibiscus cannabinus* on the black soil. The variety was from El Salvador via Kitale. The object was to test the effect on fibre yield of sulphate of ammonia, double superphosphate and muriate of potash, each at three rates of application, and applied just before sowing. Plot size was approximately 1/180th acre and there was only one replicate of 27 plots. Growth was generally poor. There was a small progressive but significant yield increase from 75 and 150 lb. per acre of double superphosphate but no response to sulphate of ammonia at 1 cwt. or 2 cwt. per acre or to muriate of potash at 75 lb. and 150 lb. per acre. However, the mean yield of clean, dry fibre was only 370 lb. per acre which would be quite uneconomic. Results so far with this crop are more promising on the red soil than on the black soils of Mwea/Tebere.

Variety Trial

TOMATOES

This trial, which was planted in September, 1956, was harvested early in 1957, too late for inclusion in the 1956 Annual Report. The object was to compare the yield and canning quality of 22 varieties of tomato under irrigation on the red soil area of the station. The design was four randomized blocks, but as the stand was very uneven the four plots of each variety were harvested together. The best yielder was San Marzano at 6.67 tons of saleable fruit per acre, followed by Lampadina (5.97 tons) and Costoluto Paullo (5.31 tons). The remaining 19 varieties each yielded less than 4 tons per acre. Tests for canning quality suggested that San Marzano, the highest yielder, was also likely to be the most acceptable for canning.

Disease and Pest Control Trial

The object of this trial was to test the effect of various spraying treatments for the control of tomato blight, *Phytophthora infestans*, and the fruit borer, *Heliothis* sp., on irrigated tomatoes on the red soil. The trial was done on four varieties: Costoluto Paullo, San Marzano, Bonny Best and D.M.M. Corstophine. There were four spraying treatments consisting of various times of application of a mixture of Burgundy Mixture and D.D.T.—namely, weekly versus fortnightly versus weekly during wet weather only versus nil. The layout was four adjacent rows of each variety with the four spraying treatments randomized within each variety. The trial was planted in the short rains (November, 1956) and harvested between February and May, 1957. There was a very significant increase in yield from spraying but no significant difference between the three spraying times. The design of the experiment, however, prevented an accurate separation of the effects of the Burgundy Mixture and D.D.T. on yield or of the best times of application of these separately. A new trial to separate these effects was started later in the year.

L. J. COLLINGS-WELLS,
Agricultural Officer (Irrigation Research).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), SOUTHERN PROVINCE, 1957

Note.—The reports of the Pasture Research Officer and the Plant Breeder, Katumani, have been incorporated in the Annual Reports of the Senior Pasture Research Officer and the Senior Plant Breeder respectively.

WEATHER

Rainfall for the year was 44.52 in., which is about 20 in. more than normal. Both the long rains and the short rains were favourable for planting and crop growth. The rainfall at Katumani is given below:—

	1957	Average (36 years)
	<i>in.</i>	<i>in.</i>
January	7.95	1.31
February	0.88	1.55
March	3.67	3.42
April	7.17	6.36
May	5.50	2.01
June	0.49	0.33
July	0.15	0.08
August	Nil	0.09
September	0.22	0.37
October	1.58	1.33
November	8.71	4.39
December	8.20	3.10
	44.52	24.35

The continuation of the 1956 short rains up until the end of January, 1957, prolonged the harvest and seriously curtailed the time available for the preparation and planting of the long rains crops.

The long rains started early in March, then stopped for two weeks and did not get into full stride until the middle of April. Although they continued until the end of May and the general harvest was good, the patchy start—necessitating the replanting of misses—did not make for good experimental results.

The short rains started rather late, but continued so well that there will be an exceptionally good harvest.

Experimental Work

KATUMANI

Ridging and Phosphate Placement Trial

A factorial trial to compare flat cultivation with cultivation on 3 ft. and 6 ft. ridges and no phosphate with $1\frac{1}{2}$ cwt. of double supers placed just below the seed and 6 in. below the seed was started at Katumani. It was planted with yellow maize. Bird damage on the seedlings was more severe on the ridged plots than on the flat and necessitated replanting. The maize on the 3 ft. ridges out-yielded maize on the flat by one bag per acre, this increase being significant at the 5 per cent level. The 6-ft. ridging treatment gave only a non-significant increase of half a bag per acre. Deep placement of phosphate likewise increased the yield by one bag per acre whereas shallow placement gave the non-significant increase of half a bag only. This latter result is unusual since normally this soil shows a very marked response to shallow-placed phosphate.

Phosphate, Lime and Rate of Application Trial

A factorial trial with two replicates was laid down with the object of trying four rates of phosphate applied every season, every other season and every fourth season. The crop planted was again yellow maize. It will not be possible to assess final results until at least eight seasons have passed. However, the first season's results have shown a marked response to all rates of phosphate.

MAKAVETE

N.P.K. Exploratory Trial

The exploratory fertilizer trial started in 1952 continued. This is a 3³ factorial trial comparing three rates of nitrogen, phosphate and potash. There are two replicates. The interesting feature of this trial now lies in the residual effects of phosphate. The original applications in 1952 consisted of no phosphate, $\frac{1}{2}$ cwt. of double supers per acre, and 1 cwt. of double supers per acre. These rates were applied both in the long and short rains of that year. In the short rains, 1955, phosphate was applied in place of the original nitrogen treatments at the rates of none, 1 cwt. and 2 cwt. double supers per acre.

In the short rains of 1956 a crop of bulrush millet was grown. The higher level of phosphate applied in 1952 still gave a significant residual effect. The phosphate applied in 1955 gave a crop response both at the lower and higher levels of application significant at the 5 per cent and 1 per cent probability levels respectively. In the 1957 long rains, a crop of Canadian Wonder beans was grown. Again, in this tenth residual season, a significant response to the 1952 application of double supers at the higher level was still recorded, and significant increases were also recorded for both levels of phosphate applied in 1955 at the same probability levels as in the 1956 short rains crop.

KAMPI-YA-MAWE

N.P.K. Exploratory Trial

A similar trial to that described immediately above exists at Kampi-ya-Mawe. There still appeared to be residual effects to the phosphate but these did not reach significance in the sorghum crop planted in the 1956 short rains. Bird damage to the 1957 long rains millet crop and poor rains resulted in very low yields which provided no reliable evidence.

Ridging and Phosphate Placement Trial

This trial is a replicate of the one at Katumani but is on a very different soil type. Results from the first season's crop of Dobb's sorghum are not reliable due to bird damage.

Panicum milliaceum Spacing Trial

A trial of Latin square design compared sowing *Panicum milliaceum* in rows 9 in., 12 in. and 18 in. apart and broadcasting the seed. Significantly better yields were obtained from broadcasting than from spacing in rows either 12 in. or 18 in. apart. Spacing in 9-in. rows also produced results inferior to broadcasting but not significantly so.

Maize Variety Trial

Muratha maize was compared with a yellow maize and two locally selected white types in a randomized block experiment. Muratha maize did not differ significantly in yield from the two white types. However, yellow maize outyielded the others by an amount significant at the 1 per cent level.

Arbicide Trials

The object of these trials is to find an arbicide capable of killing *Acacia pennata* which grows extensively in the southern areas of Machakos District. No matter what physical damage the upper parts of this tree sustain, its very deep roots will produce extensive regeneration within two or three seasons. Its control is one of the major problems of this area. Plots consisted of ten individuals and treatments consisted of various concentrations in water and diesel of the following applied to the complete bush and also to cut stumps:—

Meeno (Aminotriazole, 85 per cent).

Weedozol (Aminotriazole, 50 per cent).

Finopal (2,4-D, 40 per cent, and 2,4,5-T, 20 per cent).

Weedone (2,4,5-T).

Weedone Brushkiller 64.

Weedone LV 4.

Trioxone Oil-soluble 2,4,5-T.

Weedone Industrial Brushkiller (2,4-D, 25 per cent, and 2,4,5-T, 25 per cent).

The treatments were applied in the middle of the 1956 short rains and it is still premature to draw definite conclusions, as regeneration may still be going on. However, it would appear that the most successful treatment to date on the complete bush is Weedone 2,4,5-T in a 1 per cent mixture with water. This has so far given 100 per cent control.

There appears to be no difference between spraying cut stumps immediately on cutting or one month later, and this is probably the most economical method of control. Finopal, Weedone 2,4,5-T, Weedone Brushkiller 64 and Trioxone oil-soluble 2,4,5-T have all so far given 100 per cent control when used in this fashion.

These trials, however, were on too small a scale to permit definite conclusions to be drawn regarding cost so, at the same time, two one-acre plots were sprayed with (a) crude 2,4,5-T in diesel and (b) Trioxone water-miscible 2,4,5-T. The first treatment cost Sh. 105 per acre and the second Sh. 58 per acre. Both treatments appear to be reasonably successful, and at the end of the year regeneration of *A. pennata* was still only something of the order of 20 per cent.

At the end of the long rains another series of trials was started, using the following compounds:—

(1) Phordester (2,4-D).

(2) Trioxone Water-miscible 2,4,5-T.

(3) Karmex (C.M.U.).

(4) Phordene 50 (2,4-D).

(5) Phortox (2,4,5-T).

(6) Phenoxylene Plus (M.C.P.A.).

These were all applied on one-acre plots, quartered for four times of application as follows:—

(1) Beginning of rains (applied 16th June, 1957).

(2) Early and late rains (first application 14th November, 1957; second to be applied long rains, 1958).

(3) Mid-rains (applied 3rd December, 1957).

(4) Late rains (to be applied long rains, 1958).

At the moment the most successful treatment appears to be Trioxone water-miscible 2,4,5-T applied in the middle of the short rains. It has given an 80 per cent kill of all the more troublesome bushes, but for how long the "kill" will last is not yet known.

These trials are being continued and more treatments are being included, i.e. burning, application at long intervals, the strip method of C.M.U. applications, etc.

Exploratory Fertilizer Trials

Out of 25 short rains 1956 trials harvested at the beginning of the year, only 13 could be taken as giving some indication of the soil requirements. Out of 19 trials planted in the long rains of 1957, only two were lost—both due to the over zealousness of the owner.

Unfortunately, the majority of these trials were planted with sorghum which was badly attacked by birds, and the season was not helpful to the good farmer who planted early. The long rains results were very disappointing.

The main picture would appear to be that of a high phosphate response on the reddish soil of the hill areas and Makueni (Watuka area). There now appears to be a nitrogen response of the pallid soils of the low areas and this may explain the decrease in yield due to farmyard manure found on some sites in these areas.

It would appear that sulphate of ammonia may be more important than was previously thought, as with a short growing season it is essential that plants get away as quickly as possible. At this most crucial time it is very often cold and wet and especially on new or heavily manured land there is little nitrate breakdown. Also, the farmer, because of the continuing rain, considers weeding a waste of time and labour—thus causing even more competition for the small amount of nitrogen available.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), COAST PROVINCE, 1957

Weather

The Coast has been favoured with better than normal rainfall this year. Matuga, which since the start of the station has had a succession of bad rains, recorded 53.77 in. for the year.

Since the break of the long rains in mid-April, the only dry periods of any note have been a fortnight in June when drying winds checked the maize at a critical time, and a six-week period from mid-September to the end of October, prior to the short rains. The rainfall for the short rains period was 14.32 in.

Cassava Variety Trial

A cassava variety trial comparing the most promising of the Amani hybrids from previous trials was planted at Shimba Hills in May, 1956, and harvested after 13 months' growth. The yields of the four varieties included in the trial were good as the following table shows:—

TABLE I—YIELDS OF CASSAVA ROOTS IN TONS/ACRE

Varieties	4697/4	46110/9	46106/26	46106/27
Tons/acre ..	7.77	7.02	7.25	8.91

The superiority of 46106/27 was not significant in this trial but when considered with its performance in other trials and its palatability and disease resistance it is by far the best variety that has gone throughout our trials to date. This variety is now being introduced into the African reserves to replace the present diseased stock.

Cotton Variety Trials

Further variety trials at Kibarani and the Cotton Research Station, Msabaha, compared UK55 with UK51, the variety in general release; and the old variety N17. The design was the same as in previous years; randomized blocks with plots 1/80th acre in size. With the adequate rainfall, germination and growth were good and an even stand count was obtained. The usual pests were recorded on all varieties. N17 reacted strongly to Jassid attack, and at Msabaha it was noted that UK51 had higher populations of stainers than the others. The two UK varieties were markedly better than N17 at both sites, the difference achieving significance at $P = 0.1$ per cent probability. The higher yields at Kibarani compared with Msabaha can be attributed to the better fertility of the site which had been cleared from bush for this trial and may well be the reason for the better performance of UK55.

The results are summarized below:—

TABLE II—MEAN YIELD OF SEED COTTON IN LB./ACRE

SITE	UK 51	UK 55	N 17	L.S.D.		
				5%	1%	0.1%
Msabaha	786	694	569	67	92	123
Kibarani	1,151	1,177	823	77.5	105	142

Rainfall at the two sites was similar; Kibarani recording 25.74 in. and Msabaha 23.90 in. Although no differences were noted between varieties in the quality of cotton produced, there was considerable difference due to site. At Msabaha, Grade A cotton was only 32.5 per cent of the pick, while at Kibarani it was 65 per cent of the total crop.

Date of Planting Trial

This trial at the Cotton Research Station reported on last year was repeated again and is of interest for the different results obtained in this year when conditions were considerably better. The same sowing dates were repeated comparing sowing (1) as early as possible at the beginning of the rains, (2) after some rain had fallen, (3) after considerable rain had fallen, and (4) late in the rains. The same site was chosen for the experiment to test for residual benefits of the mulch applied in the first year of the trial.

Last year, with poorly distributed rains, there was considerable advantage to be gained from planting early in the rains, but this year there was little difference between yields for the different sowing dates although the same trends are visible. The early sown cotton suffered heavily from a variety of pests including stem borers, leaf-eating caterpillars and aphids and also from an attack by *Ramularia areola*. The combined effect of these attacks may well have nullified any advantage gained from earlier sowing.

The residual effects of the mulch produced more vigorous seedlings but this initial advantage was not reflected in the final yield except as a significant depression in the percentage of Grade A cotton from mulched plots (F test significant at $P = 1$ per cent).

TABLE III—MEAN YIELD OF SEED COTTON IN LB./ACRE

Date of Planting					Mulched	Unmulched	Mean
27-3-57	..	..	..	..	710	691	700
16-4-57	..	..	..	..	740	709	725
29-4-57	..	..	..	..	732	689	711
11-5-57	..	..	..	..	733	655	694
					729	686	708

Coefficient of variation between main plots=15.06% and between sub-plots=10.31%

Cotton Ridging Trial

Following inconclusive results last year, a further ridging trial in the form of randomized blocks was planted at the Cotton Research Station. Eight blocks of four plants were used comparing (1) flat cultivation, (2) 3-ft. tied ridges, (3) 4½-ft. tied ridges with a single row of cotton per ridge at 1-ft. spacing, (4) 4½-ft. tied ridges with a double row of cotton per ridge spaced at 2 ft. in the row. The results are again inconclusive and it is doubtful whether the small difference that may exist between flat and ridge planting would be worthwhile for cotton.

The table summarizes results:—

TABLE IV—MEAN YIELD OF SEED COTTON IN LB./ACRE

TREATMENT	Flat	3 ft. ridge	4½ ft. ridge 1 row	4½ ft. ridge 2 rows	L.S.D. 5%
Yield ..	802	842	851	858	±179

Coefficient of variation=20.56%

Effect of Varying Resting Period and Covers

A randomized block trial was started at Kibarani in 1953, after a uniformity trial in 1952 to test the effect of varying resting periods and covers. Starting from worn-out land covers of 0, 1, 2 and 3 years were compared on the following plan. C represents a crop and R a resting cover:—

YEAR			1	2	3	4	5	6	7	8
1953..	..	..	C	C	C	C	R	R	R	R
1954..	..	..	C	C	R	R	R	C	C	R
1955..	..	..	C	R	R	C	C	C	R	R

The cropping sequence followed in the years 1953-1955 was long rains cotton in the first year and sorghum in the second and third year, with cow-peas planted in each short rains. There were four randomized blocks with eight treatments in each. The plot size was 1/20th acre split for the resting covers (1) pigeon pea and (2) Star grass, grazed. The site of the experiment was on very light, sandy soils thoroughly exhausted. In 1956 and 1957, test crops of sorghum were taken in the long rains with a green gram crop in the short rains, 1956. All test crops were poor. In addition, the 1956 crop on the plots with a pigeon pea fallow in 1955 had a strong weed growth of *Cyperus* spp., which offered a degree of competition and may have depressed yields. In 1957, frequent weeding removed that possibility.

None of the treatments restored the fertility to a satisfactory level, but in 1956 the two sequences RRR and CRC outyielded continuous cropping by 3.8 cwt./acre and 4.27 respectively (LSD at 5 per cent = 3.15 cwt./acre). The following year, however, the yields of both these sequences had slumped to the level of the continuous cropping and no significant differences were recorded between treatments.

In the first year of test cropping, pigeon pea was a more effective cover than grass, giving an average increase of 0.73 cwt. per acre (significant at $P=1$ per cent) but in its second year its residual benefits had disappeared entirely.

TABLE V

A—MEAN YIELD OF SORGHUM GRAIN IN CWT./ACRE IN 1956

			CCC	CCR	CRR	CRC	RRC	RCC	RCR	RRR	Mean
Grass	..	..	2.65	27.9	4.34	7.19	4.26	3.84	2.84	6.71	4.33
P. Pea	..	..	3.85	3.06	5.86	7.03	5.96	5.66	3.36	6.56	5.06
Means	..	..	2.84	2.93	5.10	7.11	5.11	4.75	3.10	6.64	4.70

L.S.D. between—

	5%	1%
(a) Means of the 8 main treatments	3.15	—
(b) Means of the 2 resting crops	0.538	0.730

B—MEAN YIELD SORGHUM GRAIN IN CWT./ACRE IN 1957

	CCC	CCR	CRR	CRC	RRC	RCC	RCR	RRR	Mean
Grass	2.47	4.16	4.43	3.06	2.29	3.26	2.52	4.13	3.29
P. Pea	3.34	3.06	4.41	2.60	2.09	3.44	3.20	4.23	3.30
Means	2.91	3.61	4.42	2.83	2.19	3.35	2.86	4.18	3.30

L.S.D. between means of the 8 main treatments 5% 1%
 1.55 —

Effect of Long-term Rests on Sandy Soils

A further trial on the ability of various fallows to restore or retain fertility came to completion at Matuga on the Magarini sands. This trial was a $4 \times 2 \times 2$ factorial in two replicates put down in 1953. The treatments were as follows:—

A—Continuous cultivation (a).

Three years cassava, weed fallow (c).

Three years pigeon pea, weed fallow (f).

Three years grass, grazed (g).

B—Farmyard manure at 10 tons per acre (d) versus nil.

C—Phosphate at 1 cwt. of double superphosphate per acre (p) versus nil.

The farmyard manure and phosphate were applied at the start of the experiment in 1953. The continuous cultivation was cotton in 1953 with a cereal in 1954 and 1955. The long rains crops were followed by green gram in the short rains of 1954 and 1955. The pigeon pea continued until the end of 1954, grass and weeds being allowed to develop underneath. These provided a good cover in 1955. Cassava stayed in the ground until September, 1954, by which time a good cover of grass had developed. The star grass was not productive. It provided a good cover but had a very low carrying capacity.

A test crop of sorghum was taken in 1956 and again in 1957. The 1956 crop was attacked by army worm and had to be replanted. This late planting gave a poor crop as the rains finished early. The results for 1956 are given in Table VII. The only significant difference is the improved yield given by the residual effect of the combined phosphate and farmyard manure on the plots with pigeon pea or cassava fallow:—

TABLE VII

A—MEAN YIELD OF SORGHUM GRAIN IN CWT./ACRE IN 1956

	(1)	p	d	pd	Means
a	4.07	6.78	8.64	7.18	6.79
c	3.70	6.07	8.12	13.74	7.91
f	8.54	6.21	6.40	12.47	8.41
g	7.38	5.35	6.59	7.25	6.64
Means ..	5.92	6.10	7.44	10.29	

L.S.D. between marginal means 5% 1%
 2.12 2.94
 L.S.D. between treatment means 4.24 5.88

B—MEAN YIELD OF SORGHUM GRAIN IN CWT./ACRE IN 1957

				(1)	p	d	pd	Means
				2.21	1.09	3.32	3.29	2.48
a	..	..	..	3.63	5.18	4.73	6.18	4.93
c	..	..	..	4.49	4.79	5.24	6.45	5.24
l	..	..	..	4.08	3.63	5.17	3.23	4.03
g	..	..	..					
Means	..	..	..	3.60	3.67	4.63	4.79	

	5%	1%
L.S.D. between marginal means	0.976	—
L.S.D. between treatment means	1.95	—

In 1957 the pigeon pea and cassava fallows showed some advantage over the grass and continuous cultivations but fertility was at a very low ebb and some difficulty was experienced in obtaining a stand of the sorghum. The residual fertilizer effects had fallen to a straight response to farmyard manure, the phosphate having passed completely out of the picture. This is remarkable as manure has little effect after the second year in neighbouring experiments. The comparable performance of the cassava with the pigeon pea indicates that the need is to produce a good growth of vegetative matter to retain existing fertility in a growth cycle and not to rely on grazing grass without fertilizer additions or the doubtful ability of legumes to fix nitrogen.

Ridging Trial

This trial comparing various ridging techniques with two depths of phosphate placement was reported on last year. In that year, yields of sorghum were over a ton to the acre with a depression in yield when phosphate was placed deep in 6-ft. ridges. This year, with good rainfall during the growing season (28.87 in.), crop levels had fallen to an average 5 cwt./acre with extreme variability within treatments and even within plots. Fertility was low on this experiment to start with and it would seem that a good crop has exhausted the land and that phosphate alone is not sufficient to sustain growth in succeeding years.

Ridging, Mulching and Fertilizing Trial

The first year of this 3³ factorial was reported in last year's report. The long rains crop of maize suffered from a nitrogen shortage but the short rains gram crop gave good progressive responses to the light and heavy mulches and to the two depths of phosphate placement. At the beginning of the second year the ridges were remolded and the mulches reapplied, phosphate was left to test for residual responses. This year, long rains maize crop showed no benefit to ridging but gave good responses to the phosphate residues, the shallow placement (P1) increasing the yield by 1.70 cwt./acre and the deep placement (P2) by 2.72 cwt. The mulching, too, gave good responses increasing the yield by 3.04 cwt. for the light mulch (M1) and 2.86 cwt. for the heavy mulch (M2).

TABLE VIII—YIELD OF MAIZE GRAIN IN CWT./ACRE

M0	..	9.18	P0	..	9.64	R0	..	11.34
M1	..	12.22	P1	..	11.34	R1	..	11.47
M2	..	12.04	P2	..	12.46	R2	..	11.62

5% 1%

L.S.D. between means 1.55 2.11

R0=Flat cultivation; R1=3 ft. ridges; R2=4½ ft. ridges

Time of Nitrogen Application

A trial to discover the optimum time to apply nitrogen in the form of sulphate of ammonia was started at Matuga this year with sorghum as the crop. The trial was in the form of a single replicate of a 5×5 Latin square comparing the following times of application (a) no nitrogen, (b) 1 cwt./acre at planting, (c) $\frac{1}{2}$ cwt./acre applied at planting and $\frac{1}{2}$ cwt./acre applied after considerable rain had fallen, (d) 1 cwt./acre applied after considerable rain had fallen, (e) 1 cwt./acre in six applications at weekly intervals. Unfortunately, the design of the experiment did not remove the variability of the site and significant results were not obtained. However, the yields were good and the results do show the trends:—

TABLE IX—YIELD OF SORGHUM GRAIN IN CWT./ACRE

A	B	C	D	E
7.92	11.80	14.69	13.76	16.36

Coefficient of variation=30.4%

From the practical point of view, treatment (c) $\frac{1}{2}$ cwt. at planting and $\frac{1}{2}$ cwt. after considerable rain (three weeks later) gives the best results.

Methods of Application of Farmyard Manure and Residual Effects

This trial started in 1953, and continued in 1956, has lost much of the initial fertility variations. The design is four series of three blocks comparing farmyard manure at 9 tons/acre with the residual effects in the second and third years, farmyard manure at 3 tons/acre per annum and artificial fertilizers containing the equivalent NPK to 3 tons manure/acre, and control. Table X below shows the neat graduated responses now obtained with a grain crop such as sorghum. The artificials produce the best response followed by the 9 tons F.Y.M./acre in the current year, then the first residual year of 9 tons/acre which is equivalent to 3 tons F.Y.M./acre applied yearly, and lastly the second residual year of 9 tons F.Y.M./acre which has fallen to the level of control.

TABLE X—YIELD OF SORGHUM GRAIN IN CWT./ACRE

A/3	M/57	M/56	M/55	M/3	0	L.S.D.		
						5%	1%	0.1%
12.63	10.15	7.17	4.13	7.03	4.19	1.2	1.7	2.5

Coefficient of variation=8.79%

Sweet potatoes as a short-term root crop, however, shows very good responses to farmyard manure in its first and second years outcropping control by 2,653 lb./acre and 2,333 lb./acre while the artificial fertilizers only increased the crop by 1,160 lb./acre (L.S.D. at 5 per cent = $\pm 1,311$ lb./acre).

Similarly, the short rains green gram grown on the residuals of the long rains applications shows much better responses to the farmyard manure than to fertilizers.

TABLE XI—YIELD OF GREEN GRAM IN LB./ACRE

M/57	M/56	M/55	M/3	A/3	0	L.S.D.		
						5%	1%	0.1%
350	336	316	323	299	269	40	54	71

Coefficient of variation=13.4%

R. H. BENNISON,
Agricultural Officer (Research), Coast Province.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), RIFT VALLEY PROVINCE, 1957

Weather

COMPARATIVE RAINFALL FIGURES

	1954	1955	1956	1957
Nakuru	42.80	37.58	39.54	38.30
Njoro	46.48	38.92	42.31	33.81
Rongai	45.08	25.36	39.76	42.17
Kitale	47.91	40.12	45.01	40.27
Eldoret	38.13	39.79	43.95	31.95
Ol Joro Orok	36.79	35.28	40.96	39.22
South Kinangop Previous 6-years' average—34.43			42.10	54.25
Molo	—	45.99	46.89	44.43

Nakuru District.—Heavy rains delayed planting in the higher regions but rains towards the end of the year favoured late planting, although some areas experienced difficulty at harvest.

South Kinangop.—Over the year, conditions were close to normal except in some places where the long rains continued late.

Eldoret.—Conditions were wetter than normal in the first three months of the year but were not sufficiently so to hamper cultivations. Good rains favoured planting, although infrequent showers late in the year reduced yields.

Ol Joro Orok.—Unusually dry weather in July, September and October affected experimental work and late rains in November and December affected harvesting.

Kitale.—Rainfall was 5 in. below the yearly average and with an unusual distribution. A lack of rain at critical periods decreased small cereal yields and the coffee crop. Early planting paid off even greater dividends than in normal years.

Experimental Work

Full details of cereal observation, cereal fertilizer and cereal variety trials can be found above in the Annual Report of the Senior Plant Breeder. Results of entomological work in the Province can be found in the Annual Report of the Senior Entomologist.

Nakuru District

DRAINAGE

The mole draining trial on Johnson's farm, Londiani, is now completed and has produced the following results and conclusions:—

- (1) Ploughing and cultivations of moled areas can be carried out during much wetter periods than with unmoled plots.
- (2) After six years' cropping, the outlets of the moles deteriorated and some moles were beginning to cave in but they still effectively removed surface water in this condition.
- (3) It is estimated that the useful life of mole drains is seven to eight years on Londiani vlei soil.
- (4) Mole draining on vlei increased the yield of wheat by an average of 0.83 bags per acre over the six years the trial was down.

GRASSLAND

(a) Endebess Rhodes Grass/Clover Mixture

.. A trial designed to test legumes for their suitability to local conditions was laid down at Elmenteita. Ten varieties of legume were broadcast in strips at right angles to Endebess Rhodes grass drilled in 1-ft. rows. The Rhodes grass was drilled in at 12 lb. per acre. The legumes were inoculated and broadcast at approximately 5 lb. per acre except for Kenya wild white clover, which was sown at 3 lb. per acre. The trial received a basal dressing of 100 lb. supers per acre, and was planted on 12th July, 1957. The soil is an Njoro brown loam and had grown cereals for probably five years before the trial. The following varieties of legumes were used in the trial:—

Lucerne (ex South Africa), alsike clover, Montgomery late red, Yarloop subterranean clover, Ladino clover, Bukhara clover, giant sainfoin, Ruepells clover, Kenya wild white clover and Madrid sweet clover.

The Kenya wild white came away first with no grass in evidence. Rhodes grass germinated by 19th September, 1957, but grew very slowly. Only Ruepells, Yarloop subterranean and Madrid sweet were growing well by this date. Other varieties germinated poorly and appeared stunted, possibly due to a low rainfall and rather severe weed competition. By 14th November, 1957, the Endebess Rhodes grass showed a fair stand but was stunted in growth. Kenya wild white showed a very poor and stunted growth; Ruepells had a good germination but poor growth; Bukhara and Ladino were making no growth; Yarloop subterranean had a good take and fair growth; alsike had very poor germination and growth; lucerne had good germination but poor growth; Montgomery late red had a good take but stunted growth; Madrid sweet clover had a very good take and was the best stand in the plot.

A number of other legume/grass and undersowing trials were laid down. In no case did the legumes grow sufficiently well during or after the wheat or grass was harvested to be recommended as suitable for aftermath grazing. Growth throughout was extremely stunted and all clover suffered severely from the smothering effect of the cover crops and weeds. Even in the best cases, the clovers could provide only a few days' grazing and certainly not enough to justify their inclusion in the rotation, on economic grounds.

(b) Fertilizer Trial with a Grass/Clover Mixture at Solai (Mr. P. E. L. Howard's Farm)

A trial was started at Solai with the object of trying to induce growth of indigenous clovers in ley pasture where Rongai Rhodes grass grows away from clovers and tends to suppress them. The trial was sited on good pasture in the second year of a seven-year rotation and on Solai red brown loam in a good state of fertility. The layout consisted of eight 1/10th-acre plots unreplicated. Fertilizers were broadcast on 6th August after removing hay crop. The treatments were as follows:—

1. Basic slag	..	..	..	..	200 lb. per acre
2. Copper sulphate	..	..	..	..	10 lb. per acre
3. Copper sulphate	..	..	..	..	10 lb. per acre
Kieserite	..	..	..	..	150 lb. per acre
Basic slag	..	..	..	..	200 lb. per acre
4. Control					
5. Magnesium sulphate	..	..	..	..	150 lb. per acre
6. Gypsum	..	..	..	..	150 lb. per acre
7. Sulphate of ammonia	..	..	..	..	100 lb. per acre
8. Triple supers	..	..	..	..	150 lb. per acre

No response to any of the treatments was visible during the five months the trial was observed. This applies to both clovers and grass.

MAIZE

(a) *Synthetic Maize versus Rongai Selection*

Synthetic maize was compared with Rongai Selection, using local seed in $\frac{1}{4}$ -acre unreplicated observation plots. The crop was given a basal dressing of 80 lb. of double supers per acre and was planted on 23rd April in rows 3 ft. 6 in. apart with a within-the-row spacing of 13 in. Three seeds were planted per hole. The results can be summarized as follows:—

	YIELD IN LB. PER ACRE	
	Synthetic Maize	Rongai Selection
Cobs	3,656	3,228
Seed maize	2,804	2,432

Synthetic maize has thus given a yield increase of 372 lb. seed maize per acre.

(b) *Phosphate/Zinc Trial on Maize*

This was a simple trial to observe the response of maize to a small application of zinc since farmers are adamant that a zinc deficiency is general in the area. The treatments, applied on two unreplicated plots, consisted of no zinc and zinc sulphate at 15 lb. per acre. There was also a basal dressing of 80 lb. of double supers per acre. The fertilizers were broadcast and the trial planted with synthetic maize on 27th April, 1957.

On three different sites in the Subukia District an application of 15 lb. of zinc sulphate per acre gave a marked increase in yield as follows:—

Subukia airstrip	354 lb. per acre
Lower Subukia	344 lb. per acre
Pyrethrum plot at Subukia	592 lb. per acre

South Kinangop

FODDER CROPS

Brassica Trial

The following varieties were planted under ideal conditions in a well prepared seed-bed, the seed being dressed with Mergamma A: Rape kale, marrow stem kale, thousand-head kale, hungry gap kale, rape and Grant drum-head cabbage. Double superphosphate was applied at 150 and 200 lb. per acre and sulphate of ammonia at 112 and 150 lb. per acre was broadcast in strips across the plots two months after planting.

All the varieties got away to a good start but, unfortunately, they ran into a very dry period during the latter half of October and November, and growth came to a standstill in the rape, rape kale and Hungry Gap kale plots. The other three varieties progressed slowly, which would tend to prove that these three are

more drought resistant. The 200 lb. per acre rate of phosphate plots showed better growth than the 150 lb. per acre ones, and the sulphate of ammonia had an appreciable effect as well. Preliminary observation check weights have been taken from the marrow stem and thousand-headed kale plots, and the equivalent tonnage per acre was as follows:—

TREATMENTS	YIELD IN TONS PER ACRE	
	Marrow Stem Kale	Thousand-head Kale
1. 150 lb. Supers	10·5	8·5
2. 150 lb. Supers + 150 lb. S/A	12·8	12·2
3. 200 lb. Supers		9·5
4. 200 lb. Supers + 150 lb. S/A		14·8

GRASSLAND

Grass and Legume Trials

Grass still remains the problem crop of the district. Of the grasses planted, Westerwolths rye grass appears to be the most promising, and of the legumes, Louisiana white clover is worth persevering with. It is possible that grasses such as cocksfoot, *Phalaris tuberosa* and timothy will have to be grown on ridges and treated as row crops, and it is proposed to carry out work on these lines.

POTATOES

N, P, K Trial on Potatoes

This trial, using the variety Dutch Robijn, was planted on 28th August. Triple supers, muriate of potash and sulphate of ammonia were applied individually and in combination at 112 lb. per acre of each. It was impossible to obtain enough old seed for three replications, therefore one block was planted with old seed and two blocks with new. It is interesting to note that the growth rate of the old seed was at least seven weeks in advance of the new. This is an important factor from the point of view of blight control, weeding and the marketing of the potatoes.

The old seed block has been harvested and the following equivalent yields per acre were obtained:—

CONTROL	YIELD IN TONS PER ACRE						
	P	K	N	PK	PN	NK	NPK
9·23	12·23	14·03	10·76	13·04	13·06	13·33	16·23

Eldoret

FERTILIZERS

Comparison of Three Farmyard Manure Types and Double Superphosphate

Three types of farmyard manure were compared with a dressing of 200 lb. per acre of double supers in a 5 × 5 Latin Square. The treatments consisted of (1) open yard manure, (2) covered yard manure, and (3) pig manure, all at 10 tons per acre; treatment (4) was the dressing of supers, and (5) control. The experiment had a basal dressing of 100 lb. per acre of double supers. All three types of manure were superior to the supers; the pig manure had an outstanding effect.

The following yields, expressed in bags per acre, are based on a standard population of 9,160 plants per acre:—

Pig manure	Open yard	Covered yard	Double supers	Control
19.5	15.4	15.3	14.6	13.2

GRASSLAND

Ley Establishment Trial

Nandi *Setaria* in an observational trial, was sown directly and undersown in wheat in 7-in. and 14-in. rows in 1956, and half the trial was rolled after sowing. The results showed the following:—

- (a) rolling the seed-bed benefited the grass establishment and depressed wheat yield;
- (b) grass directly sown gave the best sward;
- (c) grass and wheat were slightly better with wheat in 7-in. rows.

ANIMAL HUSBANDRY

Pigs

Comparisons have been made between indoor and outdoor housing and *ad lib* and controlled feeding, using four Large White baconers in each treatment. Costings have been made and conversion ratios calculated. Two of three phases have been completed and so far it appears that:—

- (a) Conversion ratios are better for pigs kept outdoors and on controlled feeding.
- (b) Better conversion ratios and profits are made by rearing the pigs outdoors to 150 lb. liveweight and finishing indoors.

The results from the first two phases are conflicting and the experiment will be completed when the farm fencing complies with the standards required by the Pig Ordinance. The results are presented in Tables I and II.

TABLE I—RESUME OF OUTDOOR VS INDOOR PIG EXPERIMENTS—2ND PHASE

Group	TREATMENT	Average Time Taken	Average L.W. Gain	Average Food Eaten	Average Conversion
		<i>days</i>	<i>lb.</i>	<i>lb.</i>	
1	To Bacon Weight indoors				
	Controlled feeding ..	159	174.25	593.75	1 : 3.407
2	To Bacon Weight outdoors				
	Controlled feeding ..	138	178.25	501.5	1 : 2.813
3	To Bacon Weight outdoors				
	<i>ad lib.</i> feeding	131	176.5	674.75	1 : 3.82
4	To Bacon Weight indoors				
	<i>ad lib.</i> feeding	161	180.0	556.6	1 : 3.09
5	To 150 lb. outdoors and to				
	Bacon Weight indoors				
	Controlled feeding ..	143	181.25	519.5	1 : 2.866
6	To 150 lb. outdoors and to				
	Bacon Weight indoors				
	<i>ad lib.</i> feeding	130	179.25	585.75	1 : 3.267

TABLE II—COSTING OF OUTDOOR VS INDOOR PIG EXPERIMENTS—2ND PHASE

Group	TREATMENT	Total Cost of Rearing to Weaning at Sh. 1 per lb. L. W.	Cost of Feed at Cents 24 per lb.	Cost of Skim Milk at Cents 50 per gallon	Cost of Labour at Cents 9 per day	Cost of Housing at Sh. 1/56 Indoor at Sh. 1/56 Outdoor	Total Cost per Pig (Average)
		<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>
1	To Bacon Weight indoors						
	Controlled feeding ..	36 00	142 50	39 69	14 29	6 00	238 48
2	To Bacon Weight outdoors						
	Controlled feeding ..	36 00	120 36	34 56	12 44	1 56	204 92
3	To Bacon Weight outdoors						
	<i>ad lib.</i> feeding ..	36 25	161 94	32 75	11 79	1 56	244 29
4	To Bacon Weight indoors						
	<i>ad lib.</i> feeding ..	35 25	133 58	40 12	14 44	6 00	229 39
5	To 150 lb. outdoors and to						
	Bacon Weight indoors Controlled feeding ..	35 00	124 68	35 75	12 87	2 67	210 97
6	To 150 lb. outdoors and to						
	Bacon Weight indoors <i>ad lib.</i> feeding	36 50	140 10	32 37	11 65	2 67	223 29

Average price obtained over 24 baconers=Sh. 255/37.

Labour:

Two labourers=Sh. 156/50 per month=Sh. 5/21 per day.

As there were an average of 57 pigs during the experiments, this = 9 cents per pig per day.

DRAINAGE

Ol Joro Orok

To Compare Ridges and Cuthbertson Ditching on Vlei Land

This vlei land trial on the Government Farm, Ol Joro Orok, used single blocks. Treatments were as follows:—

- (1) Ridge and furrow (50-ft. ridges).
- (2) Cuthbertson ditching.
- (3) Ridge and furrow (12-ft. ridges).
- (4) Control.

The test crop was Lampton oats which had a basic dressing of 80 lb. double superphosphate per acre. The results may be summarized as follows:—

TREATMENT	Date Sown	Harvested	Yield, bags/acre
(1) Ridge and furrow, 50 ft.	18-5-57	8-11-57	12·7
(2) Cuthbertson ditching	18-5-57	8-11-57	14·1
(3) Ridge and furrow, 12 ft.	18-5-57	14-11-57	11·1
(4) Control	18-5-57	14-11-57	10·0

GRASSLAND

(a) Ley Establishment Trial

A randomized block experiment was laid down to test various methods of ley establishment. The ley seeds mixture used consisted of 10 lb. Danish cocksfoot and 5 lb. Italian ryegrass per acre. An overall basal dressing of 1½ cwt.

double supers and $1\frac{1}{2}$ cwt. sulphate of ammonia per acre was applied. Some of the treatments had a top dressing of fertilizer in addition and this consisted of $1\frac{1}{2}$ cwt. of sulphate of ammonia per acre applied on 3rd October, 1956. The varieties of wheat and oats involved in the undersowing treatments were respectively Ceres R.64 drilled at 80 lb. per acre and RL.1734 drilled at 50 lb. per acre. The complete treatments were as follows:—

- A—Undersowing to wheat, in 7-in. rows and top dressing.
- B—Undersowing to wheat, in 7-in. rows without top dressing.
- C—Undersowing to wheat, in 14-in. rows and top dressing.
- D—Undersowing to wheat, in 14-in. rows without top dressing.
- E—Undersowing to oats, in 14-in. rows and top dressing.
- F—Undersowing to oats, in 14-in. rows without top dressing.
- G—Direct seeding with top dressing.
- H—Direct seeding without top dressing.
- I—Wheat drilled in 7-in. rows, followed by grass in 1957 and top dressing.
- J—Wheat drilled in 7-in. rows, followed by grass in 1957 without top dressing.

The cereals were planted on 10th and 11th July, 1956, while the grass in treatments I and J were sown on 3rd June, 1957.

Analyses of the cereal yields reveal that there was no significant difference between any of the treatments. From the results it may be stated that neither undersowing, variation of spacing of the cereal from 7-in. to 14-in. rows or top dressing had any significant effect on the yields of wheat. In the case of oats, no treatment at the 7-in. row spacing was included in the trial, but there was no significant difference between the top dressing treatment and the no top dressing treatment.

Following harvest, the plots were rested, then grazed in May with the Boran herd. Following grazing, the plots were topped over with an auto-scythe to control regrowth. In June, the plots were harvested individually and the yields of green material recorded. These yields are given below. Plot size was 19 ft. 10 in. $\times$ 44 ft.

YIELDS IN LB. GREEN MATERIAL PER PLOT

Blocks I and III cut 13-6-57; Blocks II and IV cut 29-6-57

Block No.			A	B	C	D	E	F	G	H	Block Totals
I	..	..	38	36	54	81	49	22	9	109	398
II	..	..	76	32	110	34	33	27	41	36	389
III	..	..	53	13	62	64	24	21	28	43	308
IV	..	..	22	60	93	11	63	10	66	22	347
Treatment Totals			189	141	319	190	169	80	144	210	1,442

Regrowth resulted in appreciable variations within treatments. Appreciable regrowth occurred in all the oat plots, though in this case variation from plot to plot was less than that experienced in the wheat plots.

An analysis of variance showed no significant difference between treatments, although significance was almost reached. The analysis was continued in spite of this because of the great difference in yields of green material from the oat plots. Further analysis revealed that treatment C gave a significantly greater yield of green material than either B, F or G at the 5 per cent level. Treatment C gave a significantly higher yield than treatment F at the 1 per cent level. Surprisingly enough, the ley under wheat in 14-in. rows and top-dressed gave the greatest yields of green material, even greater than the grass in pure stand. The poorest treatment was undoubtedly that under oats drilled in 14-in. rows. Low yields were obtained in spite of considerable regrowth. Had the oats been sown at 7 in., the yields would have undoubtedly been extremely poor.

Later, a second cut was taken. Once again the regrowth on the undersown plots caused great variation in the treatment yields in the different blocks. That such differences should be apparent after two grazings and a cutting is rather remarkable. In this second cut, treatment C gave a significantly greater yield than did treatments B, F and G, confirming the results from the first cut. Treatments A, C and E gave significantly greater yields than I and J, a not unexpected result since, in these last two treatments, the grass was sown on 3rd June, 1957.

That the influence of the nurse crop persisted even into the second cut is surprising. The differences between the total weights to date for some of the comparable treatments as follows are interesting:—

YIELD OF GREEN MATERIAL IN CWT./ACRE

1. Sowing under oats in 14 in. rows	12.73
2. Sowing under wheat in 14 in. rows	18.81
3. Direct seeding	12.61

(b) A Comparison of Sulphate of Ammonia and Nitro-chalk in the Top Dressing of Leys

This trial to compare sulphate of ammonia and nitro-chalk for top dressing leys consisted of four randomized blocks, each with four main plots split for nitro-chalk and sulphate of ammonia. Treatments were as follows:—

A—

- (1) No nitrogenous fertilizer.
- (2) 1 cwt. of N.A.C. fertilizer per acre.
- (3) 2 cwt. of N.A.C. fertilizer per acre.
- (4) 3 cwt. of N.A.C. fertilizer per acre.

B—

- (1) No nitrogenous fertilizer.

- (2) 1 cwt. of sulphate of ammonia per acre.
- (3) 2 cwt. of sulphate of ammonia per acre.
- (4) 3 cwt. of sulphate of ammonia per acre.

The experiment was laid down on a ryegrass ley which had been cut for silage and hay on 24th May, 1957, and 29th June, 1957, respectively. The top dressings were applied on 4th July, 1957, mixed with a basal dressing of 80 lb. per acre of double superphosphate. The cuts were taken on 21st and 22nd August, 1957.

From the results obtained, it can be concluded that top dressing with either nitrogenous fertilizer significantly increased the yield of green material in the first cut from this second year ryegrass ley. There was a response to the increasing rates of application up to the 3-cwt. level. These increases were significant throughout for sulphate of ammonia, but with nitro-chalk the increase for the 3-cwt. dressing over the 2-cwt. dressing did not reach statistical significance. With both fertilizers the greater increments of yield were obtained up to the 2-cwt. level. Weight for weight, nitro-chalk gave higher yields than sulphate of ammonia at the two lower levels of application.

ANIMAL HUSBANDRY

(a) *Beef Cattle Experiment*

A trial has been run to compare the progeny of Boran, Boran $\times$ Hereford and Boran $\times$ Aberdeen Angus cattle. The first stage of the trial is completed and results so far permit the following conclusions to be drawn:—

- (1) Except for the two Aberdeen Angus $\times$ Boran steers, which were finished for the Fatstock Show, killing out percentage was fairly constant and independent of the cross.
- (2) Dead weights of Boran were lower than for both crosses.
- (3) The Hereford crosses gave, on average, heavier carcasses than did the Angus crosses, which were one month older at slaughter.
- (4) The proportion of fore to hind quarters was approximately the same for all types.
- (5) From the few carcass measurements made, the only conclusions reached were that Boran were fatter at slaughter than either cross.
- (6) It is clear that the experiment should be carried through to produce finished beasts to determine the full potentialities of the cross.
- (7) A single implantation with 60 mgm. of Hexoestrol has little or no effect on rate of live-weight gain or killing out percentage.

(b) *Outside versus Inside Housing of Pigs*

An experiment compared (i) inside housing of pigs from weaning to bacon weight, (ii) outside from weaning to 120 lb. and then inside housing until bacon weight, and (iii) outside from weaning to bacon weight. The results to date are presented in Table III.

TABLE III—OUTSIDE V. INSIDE PIG HOUSING TRIAL
TREATMENT "A"—INSIDE TO BACON WEIGHT

No.	Weaning Weight	Days to Slaughter	Date Sent off	Liveweight	Dead Weight	S.Q.	Back	Fat Shoulder	Loin	Grade	K.O. %
3	lb.			lb.	lb.						
9	54	130	9-12-57	212	151	V.F.	(A) A	(B) A	(B) A	A	71.2
12	34	218	6-1-58	197	146	V.F.	(A) A	(B) B	(A) A	A	74.1
16	30	—	—	—	—	—	—	—	—	—	—
20	35	—	—	—	—	—	—	—	—	—	—
20	41	192	23-12-57	200	150	V.F.	(A) A	(A) A	(B) A	A	75.0
25	42	192	23-12-57	199	142	V.F.	(A) A	(B) B	(A) A	A	71.2

TREATMENT "B"—OUT TO 120 LB. INSIDE TO BACON WEIGHT

No.	Weaning Weight	Days Out	Days to Slaughter	Date Sent off	Liveweight	Dead Weight	S.Q.	Back	Fat Shoulder	Loin	Grade	K.O. %
1	lb.				lb.	lb.						
8	48	77	206	23-12-57	200	147	V.F.	(A) A	(A) A	(B) A	A	73.5
10	40	77	220	6-1-58	198	141	V.F.	(A) A	(B) B	(B) B	B	71.2
14	30	77	—	—	—	—	—	—	—	—	—	—
22	35	77	192	23-12-57	197	147	V.F.	(A) A	(B) B	(C) B	B	74.6
24	41	77	199	30-12-57	200	—	—	—	—	—	—	—
24	44	77	—	—	—	—	—	—	—	—	—	—

Fat. No figures given

TREATMENT "C"—OUTSIDE TO BACON WEIGHT

No.	Weaning Weight	Days to Slaughter	Date Sent off	Liveweight	Dead Weight	S.Q.	Back	Fat Shoulder	Loin	Grade	K.O. %
5	lb.			lb.	lb.						
7	50	211	30-12-57	210	145	V.F.	(A) A	(B) B	(C) C	B	72.5
17	32	—	—	—	—	—	—	—	—	—	—
19	31	—	—	—	—	—	—	—	—	—	—
21	34	—	—	—	—	—	—	—	—	—	—
21	43	—	—	—	—	—	—	—	—	—	—
26	40	199	30-12-57	200	142	V.F.	(A) A	(A) A	(A) A	A	71.0

() = New Grading. The Sows providing the three litters for the experiments are litter-sisters. Nos. 1, 3, 5, 7, 8, 9, are from one litter; Nos. 10, 12, 13, 16, 17, 19 are from one litter. Nos. 20, 21, 22, 24, 25, 26 are from one litter.

Kitale**MAIZE***Effects of Narrow and Wide Spacing with Two-row Populations*

A trial was put down to compare narrow and wide, double-row spacing of maize with two populations per acre. The narrow-row spacing was at $3\frac{1}{2}$ ft. and the wide, double-row spacing was at 7 ft. $\times$ 2 ft. The two plant populations were 12,000 and 14,000 plants per acre. The maize was planted on 22nd April, 1957, and harvested on 30th December. The seed was dressed with Agrosan and Aldrin. The crop sustained damage from hail in June. The four treatments were in detail as follows:—

A—7-ft. $\times$ 2-ft. spaced to give 12,000 plants per acre.

B—7-ft. $\times$ 2-ft. spaced to give 14,000 plants per acre.

C—3-ft. 6-in. rows to give 12,000 plants per acre.

D—3-ft. 6-in. rows to give 14,000 plants per acre.

The results of the trial can be summarized as follows in bags of maize per acre:—

A	TREATMENTS		D
	B	C	
21·64	20·30	23·12	23·72

Differences between the treatments are not significant. There is, however, an indication that narrow-row spacing produces better yields than wide, double-row spacing. The different plant populations have not produced different yields. There was no difference in the number of lodged plants between the narrow rows and the wide, double rows.

FERTILIZERS*Effects of Gypsum, Double Supers and Urea on Maize*

Four replications of a randomized block trial were laid down to compare the effects of gypsum, double supers and urea on maize. The seed, dressed with Agrosan and Fernasan, was planted on 13th May, 1957. Details of the four treatments are as follows:—

A—Control.

B—Gypsum at 156 lb. per acre.

C—Gypsum, double supers and urea at 156 lb., 156 lb., and 100 lb. per acre respectively.

D—Gypsum and double supers as in C.

The results can be summarized as follows, yields being given in bags of maize per acre:—

TREATMENTS				SIG. DIFF.	
A	B	C	D	5%	1%
10·2	10·5	16·4	12·7	3·7	5·4

It can be seen that gypsum alone has given no increase in yield. Gypsum and double supers together have produced a non-significant increase of 2.5 bags per acre. With the addition of nitrogen in the form of urea, the yield was increased very significantly by 6.2 bags over control.

WEEDS

Methods of Weed Control

A randomized block experiment with three treatments and six replications was conducted with the object of comparing three methods of weed control in maize. The treatments comprised (A) control by cultivation alone, (B) a pre-emergence spray with 1 lb. acid equivalent per acre of Agroxone 4 and as many following applications as required, and (C) one pre-emergence and one post-emergence spray as in B and as many subsequent cultivations as required. In fact, three cultivations were necessary in A, three sprayings in B, and two sprayings and two cultivations in C. The results are presented below in terms of bags of maize per acre:—

TREATMENTS			SIG. DIFF.	
A	B	C	5%	1%
21.2	16.2	19.8	1.78	2.51

Thus three cultivations produced five more bags per acre than three sprayings with Agroxone 4. But a very bad infestation with couch grass, which is unaffected by the Agroxone 4, is doubtless a main contributing factor to this large difference. The combination of spraying and cultivation produced an inferior yield to cultivation alone but the difference of 1.4 bags per acre did not reach statistical significance. This small difference could be accounted for by early couch infestation which was not controlled by the spraying.

ANIMAL HUSBANDRY

Inside versus Outside Housing of Pigs

An experiment with bacon pigs compared (A) inside housing from weaning to bacon weight with (B) outside housing during the same period. The outside houses comprised moveable hessian shelters on leys.

No large difference between the two treatments was noted. The conversion ratio varied considerably in the different trials, but the overall difference between outside and inside housing in this trial was negligible, both being poor. There was an indication that pigs outside attained bacon weight earlier by about 13 days. Gradings were exceptionally low in both treatments without any difference in this respect.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), NYANZA PROVINCE, 1957

Weather

RAINFALL AT EXPERIMENTAL STATIONS, 1957

The monthly totals for the stations are given in the Appendix.

In general, rainfall during the year has been satisfactory over most stations; the second quarter was notable for very heavy storms over most of the Province but, generally, crops recovered from any damage to which they were subjected. The three months August-October were unusually dry at many stations and supplementary green fodder was utilized at Sotik and at Homa Bay.

Reports on Experiments

DRAINAGE AND PHOSPHATE TRIALS ON VLEI SOILS

In 1957, each of the eight drainage treatments at Sotik Post (design reported in 1955) was again planted up in strips to maize, potatoes and wheat. These crops were rotated from the 1956 layout. Also tested against these crops was a further application of 100 lb. per acre double superphosphate versus nil, the phosphate being applied to the same plots which had received it in 1956.

The treatment and yield figures were as follows:—

1. PLOTS RECEIVING FREE FLOW OF WATER FROM HIGHER LAND—

				<i>lb./acre</i>
(a) 24 ft. ridge and furrow (1 % slope) with phosphate.	Maize	..	..	1,600
	Potatoes	..	..	740
	Wheat	..	..	804
(b) 24 ft. ridge and furrow (1 % slope) with no phosphate.	Maize	..	..	1,050
	Potatoes	..	..	2,968
	Wheat	..	..	536
(c) Flat with phosphate	Maize	..	..	750
	Potatoes	..	..	3,105
	Wheat	..	..	468
(d) Flat with no phosphate	Maize	..	..	150
	Potatoes	..	..	1,240
	Wheat	..	..	299

2. PLOTS PROTECTED ON UPPER SIDE BY A BANK AND A CUT-OFF DRAIN—

(e) 24 ft. ridge and furrow (1 % slope) with phosphate.	Maize	..	..	150
	Potatoes	..	..	5,135
	Wheat	..	..	675
(f) 24 ft. ridge and furrow (1 % slope) with no phosphate.	Maize	..	..	950
	Potatoes	..	..	3,290
	Wheat	..	..	498
(g) Flat with phosphate	Maize	..	..	1,850
	Potatoes	..	..	4,520
	Wheat	..	..	787
(h) Flat with no phosphate	Maize	..	..	1,350
	Potatoes	..	..	3,328
	Wheat	..	..	702

All drainage treatments were put to a fair test in 1957, the rainfall during growth of the crops being considerably higher than in 1956. The trial is only observational in design but, comparing the figures above, the clear advantage of the cut-off drain treatment over the free flow treatment can be seen. The maize and potato yields have been doubled by this simple drainage and the wheat yield has been increased by about 25 per cent. The addition of double superphosphate at 100 lb. per acre has greatly increased the maize yield and the wheat yield to a lesser extent. There has been very little apparent response by potatoes to phosphate. Both maize and wheat have responded well to the 24-ft. ridge and furrow treatment, but potatoes have not responded.

EXPLORATORY FERTILIZER TRIALS

Forty-four exploratory fertilizer trials were laid down on the major soil types in the African areas of the Province during the year, 31 of which were harvested successfully. Results of these trials have been reported on above by the Senior Soil Chemist.

FERTILIZER RATES TRIALS

A new trial to test the effect of sulphate of ammonia, double superphosphates and muriate of potash, each at three rates of application, was laid down at Kakamega Experimental Station. The plot size is 1/40th acre, and there are two replications. The long rains crop was Dobbs White sorghum. Unfortunately, the trial was the target of a very heavy attack of *Antherigona* which prevented any attempt to assess results by grain yields. Yields of green sorghum foliage were taken. It is stressed that the yield figures given below (in lb. green material per acre) are not intended to represent a cut of sorghum taken at the silage stage.

SULPHATE OF AMMONIA		DOUBLE SUPERPHOSPHATE		MURIATE OF POTASH	
Rate cwt./acre	Yield acre	Rate cwt./acre	Yield acre	Rate cwt./acre	Yield acre
1.44	6,888.66	1.44	7,326.00	1	6,446.88
0.96	6,242.64	0.96	7,519.14	0.5	6,999.66
Nil	7,052.94	Nil	5,339.10	Nil	6,737.70
Mean	6,728.08		6,728.08		6,728.08

Least Significant difference: $p=0.05=1,498.26$

$p=0.01=2,036.44$

There was a good response to both applications of double superphosphate. The response to the 0.96 cwt./acre dressing was more highly significant than the response to the larger application. No other main effects reached statistical significance nor did interactions between treatments.

At Sotik Post (Bomet) a reapplication of 1 cwt. per acre each of sulphate of ammonia and muriate of potash was made to the rates of application trial first reported in 1956. No reapplication of phosphate treatments was made so that possible residual responses to this fertilizer could be tested. The crop was again maize. Final statistical analysis has not yet been completed but yield figures indicate a good response to residual phosphate.

FODDER CROPS

As an alternative to Napier grass, an area on the Kisii farm was planted with splits of *Setaria splendida*, a grass which has, so far, been most encouraging. Its first cut in the early flowering stage gave yields which compared very favourably with Napier grass. At Sotik, this fodder grass also shows promise. At Kakamega, the *Setaria splendida* planted in 1955 is suffering from a type of rot which has attacked the centre of the stools leaving only a periphery of green material.

At Sotik Post (Bomet), where mangolds and other roots previously have shown up well, unprecedented rains and waterlogging caused a complete failure of these crops.

LEY SPECIES OBSERVATION PLOTS

In 1957, work on ley species was, in the main, concentrated on the Kakamega and Sotik stations where maize was undersown to *Panicum maximum* var. *trichoglume*, Nzoia Rhodes, and Nandi *Setaria*. Molasses grass was also included at Sotik as it appears to persist better under the drier conditions there than at Kakamega. Legumes in mixture with these grasses under trial at Kakamega are *Trifolium semipilosum*, Hunter River lucerne, and Louisiana white clover; at Sotik, *T. semipilosum*, Louisiana white clover, *T. rueppellianum* and Booberowie lucerne are being tested. All grasses and legumes have taken well and the latter have nodulated satisfactorily after inoculation.

Eight strains of *Chloris gayana* selected at the Grassland Research Station, Kitale, were undersown to maize at both Kakamega and Sotik; all germinated well. At both stations it appears that the Nzoia and Mpwapwa types show more promise than the others (Endebess, Chepararia, Rongai, Mbarara, Alego, Kabarnet) at this early stage.

The grass/legume grids sown at Sotik and Kakamega in 1955 have now outlived their usefulness but an interesting feature at Kakamega is that *Paspalum dilitatum*, reported in 1956 to be very scanty and to have been swamped by indigenous species, now forms an almost pure stand over the area in which the seed was planted.

From general observations made on technique of undersowing maize to ley grasses and their subsequent establishment, it has become evident that the grass seed must be worked into the soil by rolling, brushing in or raking. Past methods of merely broadcasting seed between maize rows have not been satisfactory.

In the high rainfall areas there is little doubt that, of the seeded ley grasses tried, Nzoia Rhodes is the simplest to establish; Nandi *Setaria* invariably appears to germinate sporadically and is therefore slow to form a cover.

GROUNDNUT VARIETY TRIAL

Due to shortage of seed of several of the eight varieties to be tested, the randomized block design was laid down in microplots. It was thought that this would be sufficient to confirm or check the results from the same varieties in former trials.

The variety of SA/A-1=A.H. 32 significantly outyielded varieties listed below yielding less than U/A-32=S.720, but there was no significant difference between any of the first four varieties listed. The low yields of the last three varieties can be ascribed almost entirely to heavy rosette disease incidence on these types.

Varietal yields are given below in bags (180 lb.) dry shelled nuts per acre:—

VARIETY	Yield Bags (180 lb.) dry shelled nuts/acre
SA/A—1=A.H.32	6.30
SA/A—2=Masambika	5.86
SA/A—5=42-G-105	5.09
U/A—32=S.720	5.01
Nyanza local (Valencia Bunch)	3.99
Nyanza local (Njugu Machon)	3.07
Homa Bay Farm Variety	2.99
U/A—8=B.688	1.89
Mean	4.27
Least Significant Difference—	
p=0.05	2.26
p=0.01	3.08

POTATO VARIETY OBSERVATION PLOTS

These plots were first mentioned in the 1956 Report but yields figures were not given as they had not then been harvested. They were harvested in March, 1957 and yield figures are given below. All varieties were planted on ridges 3 ft. apart with seed tubers 15 in. apart on the ridge. Farmyard manure was applied at nine tons per acre before ridging.

VARIETY	Yield tons per acre
C.53	6.96
E.52	5.13
K.52	4.87

A similar trial planted at Kisii was unsuccessful due to a disastrous attack of bacterial wilt (*Pseudomonas solanacearum*).

A further observational trial with seed from the earlier trial was planted at Kakamega in September, 1957, and harvested in December; due to poor rains during these months, yields, which are given below, were very poor.

VARIETY	Yield tons per acre
K.52	2.47
C.53	2.43
E.52	1.33

As in 1956, C.53 and E.52 were attacked by *Alternaria* early blight (which appears late in the growing season at Kakamega). K.52 was almost unaffected.

RICE OBSERVATION PLOTS

At Komomange in the Suba/Kuria division of South Nyanza, an observational trial was planted to find the highest yielding of the varieties Sindano, Mbuyu and Kihogo, and also to note the difference in yield, if any, between broadcasting seed at 150 lb./acre versus row planting of seed at a spacing of 1 ft. $\times$ 9 in., leaving five seeds at each site (estimated seed rate of 50 lb./acre). The trial was planted in a hanging swamp where there was no controlled irrigation.

Yield figures are given below in bags (160 lb.) of paddy per acre.

VARIETY					Row planted	Broadcast	Mean yield for varieties
Sindano	..	..	..	..	17.33	17.97	17.65
Mbuyu	..	..	..	..	8.67	6.29	7.48
Kihogo	..	..	..	..	7.56	8.72	8.14
Mean	..	..	..	..	11.18	10.99	

SORGHUM VARIETY TRIAL

This trial of five varieties was laid down at Kabosson to test the two highest-yielding white-grained varieties in the Kibos collection against three new varieties ex Sudan. Dobbs ex Kongwa has outyielded all varieties except Dobbs ex Bukura at the 1 per cent level of significance. Yields were quite exceptionally high and it is difficult to account for this except that the plot size of 1/193.6th acres was very small; this plot size was necessitated by the shortage of seed of the Sudan varieties. Yield figures were:—

VARIETY					Yield Bags (180 lb.) per acre
Dobbs ex Kongwa	..	..	..	..	21.77
Dobbs ex Bukura	..	..	..	..	21.70
Wadum Benein Bulk V	..	..	..	..	13.14
Fet. maatuk	..	..	..	..	7.31
Wadum Benein Bulk II	..	..	..	..	5.76
Mean	..	..	..	..	13.93
Least Significant Difference—					
p=0.05	..	..	..	..	5.03
p=0.01	..	..	..	..	7.34

SUGAR CANE VARIETY TRIALS

The trial of five varieties repeated on both the upper red and lower black soils of Miwani Estate has reached its second ratoon harvest and is now concluded. Previous crops have been reported in 1955 and 1956.

Yields of cane and of sucrose are given below for the second ratoon of both trials.

1.—SECOND RATOON HARVEST: UPPER RED SOIL

VARIETY	Yield tons cane/acre	Yield of sucrose tons/acre (calculated by Java Ratio)
Co.331	32.26	3.96
Co.421	24.70	3.26
Co.408	19.76	2.46
Co.419	19.26	2.40
Co.213	15.56	1.84
Mean	22.32	
Least Sig. Diff.—		
p=0.05	3.43	
p=0.01	4.82	

The variety Co.331 has outyielded all other varieties at the 1 per cent level, Co.421 has outyielded Co.408, Co.419 and Co.213 at the 5 per cent level.

2.—SECOND RATOON HARVEST: LOWER BLACK SOIL

VARIETY	Yield tons cane/acre	Yield of sucrose tons/acre (calculated by Java Ratio)
Co.331	27.06	2.50
Co.421	21.09	2.44
Co.408	14.96	1.73
Co.419	12.94	1.36
Co.213	12.59	1.41
Mean	17.72	
Least Sig. Diff.—		
p=0.05	3.88	
p=0.01	5.44	

The variety Co.331 has outyielded all other varieties at the 1 per cent level, Co.421 has outyielded Co.408, Co.419 and Co.213 at the 1 per cent level. It is interesting to note that the order of varieties according to their yields is exactly the same for the two second ratoon crops.

In 1955, two variety trials were planted in the Songhor/Muhoroni area, one on Mrs. Martin's farm and one on Mr. Turton's farm. These trials of five varieties each were laid down as Latin squares on both sites. Two varieties (Co.411 and Co.419) were stolen in their entirety from Mrs. Martin's trials. Results for the three remaining varieties in their plant crop harvest are given below:—

VARIETY	Cane Yield tons/acre	Sucrose Yield tons/acre
Co.453	50.47	6.03
Co.331	49.34	5.23
Co.421	39.52	4.84
Mean	46.44	

Yield figures for the trial at Turton's farm are given below. All varieties were harvested successfully:—

VARIETY	Cane Yield tons/acre	Sucrose Yield tons/acre
Co.331	43·94	4·60
Co.453	36·12	4·28
Co.421	35·14	4·47
Co.419	34·00	4·12
Co.411	29·29	3·67
Mean	35·70	
Least Sig. Diff.—		
p=0·05	11·74	
p=0·01	16·46	

Co.331 has outyielded Co.411 significantly at the 5 per cent level. There is no significant difference between the yields of other varieties. Yields, though not high, compare favourably with some trials on the Miwani Estate and show that sugar cane could be a useful crop in this area.

A large trial to test the yields of 25 varieties under irrigation was planted at Miwani in 1955. The design is a 5×5 balanced lattice square with three replications and plot size 1/50th acre. The trial was periodically irrigated by flooding, giving a total of 105 in. of water applied to the trial inclusive of rainfall over a period of 21 months. The plant crop was harvested in February, 1957. Yield figures are given below:—

VARIETY	Yield tons cane/acre	Sucrose Yield tons/acre
Co.419	77·50	9·98
Co.408	73·00	8·64
B.41227	73·00	8·69
B.41211	71·00	9·05
B.37193	70·50	8·58
Co.331	69·50	7·46
P.o.J.2961	69·00	8·28
Co.421	67·50	8·14
P.o.J.2875	66·00	7·66
Co.453	65·50	7·15
N.Co.310	65·00	8·58
M.134/32	65·00	7·56
N.Co.79	64·50	—
N.Co.291	62·00	7·72
B.3337	61·00	7·04
B.3215	56·50	7·69
Co.404	55·50	6·52
PR.809	54·00	6·29
B.3172	53·00	6·76
P.o.J.2878	53·00	6·36
P.o.J.2714	52·50	6·15
P.o.J.2725	51·50	6·00
Mayaguez 151	51·50	7·01
B.35237	41·50	5·44
B.35245	40·00	5·07
Mean	61·16	
Least Sig. Diff.—		
p at 0·05=	13·85	
p at 0·01=	18·15	

Yields of cane and of sucrose were the highest obtained in any trial in Nyanza.

Co.419 has outyielded all varieties listed below B.3337 at the 1 per cent level and below N.Co.79 at the 5 per cent level. Co.408 and B.41227 have outyielded those listed below B.3337 at the 5 per cent level.

At the outset of this trial it was hoped that the yield of the high sucrose content Barbados canes would improve under irrigated conditions. On the plant cane crop this hope seems to have been justified at least for some of these varieties.

Yield figures for N.Co.79 should be treated with reserve as setts of this variety appeared to have been mixed with others whilst gapping up the trial.

SUGAR CANE FERTILIZER TRIAL, MIWANI

The plant and first ratoon crops of this trial were reported on in the 1955 and 1956 reports. As a result of the significant yield increases obtained from the reapplication of fertilizers to the first ratoon crop a further application of nitrogen, phosphate and potash was made to the second ratoon stools. Dosages of these fertilizers were as follows:—

(a) Sulphate of ammonia at nil, 200 lb. and 400 lb. per acre.

(b) Double superphosphate at nil, 120 lb. and 240 lb. per acre.

(c) Muriate of potash at nil, 120 lb. and 240 lb. per acre.

Fertilizers were applied in shallow drills 6 in. from the cane stools on each side of the rows. The variety of cane is Co.281.

The analysis of the second ratoon crop, which was harvested in October, 1957, showed significant responses to both levels of sulphate of ammonia, both levels of phosphate and to the higher rate of potash; there were no significant interactions between any of these fertilizers.

Yield figures are given below in tons of cane per acre.

SULPHATE OF AMMONIA		DOUBLE SUPERPHOSPHATE		MURIATE OF POTASH	
Rate lb./acre	Yield acre	Rate lb./acre	Yield acre	Rate lb./acre	Yield acre
400	43.92	240	40.24	240	41.16
200	41.54	120	39.37	120	38.32
Nil	30.27	Nil	36.12	Nil	36.25
Mean	38.58		38.58		38.58

Least Significant Difference: p at 0.05=2.88

p at 0.01=3.92

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APPENDIX

RAINFALL AT EXPERIMENTAL STATIONS, 1957, (INCHES)

	Kakamega	Kisumu	Kibos	Miwani	Kisii	Homa Bay	Sotik	Busia	Sotik Post
January ..	2.84	3.43	3.31	3.21	3.49	2.66	3.46	4.05	5.09
February ..	2.94	4.95	2.75	2.23	3.52	1.86	1.21	1.67	2.41
March ..	7.16	3.83	2.58	4.94	7.75	4.67	3.67	8.06	6.38
April ..	11.85	8.94	9.12	6.34	13.87	5.10	12.07	8.52	11.91
May ..	8.03	9.07	8.30	5.14	8.56	6.71	11.02	7.40	6.52
June ..	6.16	1.00	2.78	5.48	6.87	2.75	7.15	3.36	9.74
July ..	8.52	2.98	2.47	3.36	4.77	1.13	3.44	4.47	1.63
August ..	6.03	2.73	2.79	5.43	7.00	2.34	2.95	5.33	3.12
September ..	2.31	0.31	1.47	0.85	6.87	3.04	1.52	4.21	2.75
October ..	3.20	2.98	2.09	4.31	2.38	0.73	2.43	2.89	2.13
November ..	2.36	4.51	5.60	2.77	8.35	3.45	3.62	5.78	2.53
December ..	5.31	6.32	5.04	6.88	7.49	2.13	6.72	2.82	4.05
TOTAL ..	66.71	51.05	48.30	50.94	80.92	36.27	59.26	58.56	58.26

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), CENTRAL PROVINCE, 1957

Rainfall

	EMBU		MULINDUKO		KANJA	
	Inches	Days	Inches	Days	Inches	Days
January ..	1.54	6	1.9	7	3.23	13
February ..	0.13	2	0.29	2	0.49	7
March ..	4.17	16	1.27	7	1.75	13
April ..	10.20	22	10.9	19	8.76	26
May ..	14.51	24	9.71	18	11.70	26
June ..	0.73	9	0.16	5	1.79	16
July ..	1.59	16	0.56	7	1.06	19
August ..	1.51	18	0.47	7	1.65	23
September ..	3.85	7	0.73	4	0.65	5
October ..	7.61	17	2.83	7	6.13	14
November ..	10.27	20	7.22	17	7.75	24
December ..	2.58	10	3.16	9	3.21	10
Total ..	58.69		39.20		48.17	

At Embu, precipitation was 17 in. above the 40-year average of 41.58 in. It was well distributed. Similarly, Mulinduko received an above average quota of rain. Kanja rainfall was well distributed and in reasonable quantity. The Gathano was protracted.

Report on Experimental Work

1. HIGH BRACKEN ZONE

Fertilizer and Farmyard Manure Trial

This trial is one replication (32 plots) of a 2⁵ factorial. Its object is to test the effects of double superphosphate at 1½ cwt. per acre versus nil, sulphate of ammonia at 3 cwt. versus nil, muriate of potash at 2 cwt. versus nil, magnesium sulphate at 2 and 1/7th cwt. versus nil and farmyard manure at 15 tons versus nil. The test crop in 1956 was English potatoes, results of which were published in last year's report. A short rains crop of dwarf beans preceded Lampton oats, broadcast for silage in the long rains, 1957. There was no reapplication of treatments. Yield estimation was based on a single autoscycyte cut of 12 square yards per plot.

TABLE OF RESULTS—LONG TONS FRESH GREENSTUFF PER ACRE—LAMPTON OATS

				(1)	P.	Mean	Difference
No.	FYM..	..	..	5.92	8.37	7.14	
	FYM..	..	..	10.35	10.71	10.53	+3.39**
	Mean ..	..	..	8.13	9.54	8.84	
	Difference	..	..		+1.41*		

Yield of Nil plot=3.96 tons.

Coefficient of Variation=20.8%.

L.S.D. at 1% level of t=1.96 tons per acre**

at 5% level of t=1.41 tons per acre*

The residual effect of farmyard manure applied to the preceding long rains crop of English potatoes is highly significant. The residual effect of double superphosphate is significant at the 5 per cent level of *t*. The interaction is not significant.

Lime, Phosphate and Farmyard Manure Trial

This trial was begun in 1956 to obtain information on responses to double superphosphate at 2 cwt., 1 cwt. and nil; lime at 6 tons, 3 tons and nil; farmyard manure at 10 tons, 2 cwt. sulphate of ammonia and nil, and their factorial combinations. All figures are on a per acre basis. In 1957, the 2 cwt. sulphate of ammonia was changed to 5 tons per acre farmyard manure. The design is a 3^3 factorial, plot size is $1/40$ th acre, and there are two replications. The 1956 crop was Gathano planted maize and the 1957 long rains crops Dutch Robjyn potatoes. The crop was severely blighted in its final stages. The superphosphate and farmyard manure treatments were re-applied prior to planting the potatoes.

TABLE OF RESULTS—YIELDS IN LONG TONS FRESH TUBERS PER ACRE

		L0	L1	L2	P0	P1	P2	Mean
M0	.. ..	2.51	1.89	2.59	1.35	2.48	3.04	2.29
M1	.. ..	3.85	4.79	3.99	3.73	3.95	4.93	4.20
M2	.. ..	4.29	4.62	3.84	4.17	4.32	4.26	4.25
Mean	.. ..	3.54	3.75	3.45	3.08	3.58	4.07	3.58

			P0	P1	P2
L0..	.. ..		3.09	3.83	3.70
L1..	.. ..		3.45	3.83	3.96
L2..	.. ..		2.71	3.09	4.56

Yield of the Nil plots—1.65 tons per acre.

L.S.D. at 1% level of $t=1.12$
5% level of $t=0.83$ } Between Marginal Means.

L.S.D. at 1% level of $t=1.94$
5% level of $t=1.44$ } Within body of the table.

Significant increases were produced by both levels of farmyard manure and by double superphosphate at 2 cwt. per acre. No interactions reached significant level.

2. STAR AND KIKUYU GRASS ZONE

Exploratory Fertilizer Trial

This experiment was started at Embu in 1952 as an initial investigation of fertilizer responses on the Embu Investigation Centre farm. Treatments were sulphate of ammonia at 0, 1 and 2 cwt. per acre, double superphosphate at 0, 1 and 2 cwt. per acre, and muriate of potash at 0, $\frac{1}{2}$ and 1 cwt. per acre combined in two replications of a 3^3 factorial layout, with NPK confounded. Due to the repeated failure to obtain a potash response, in 1956 the relevant treatment was changed to "Time of undersowing of Rongai Rhodes grass (*Chloris gayana*)—K0=16 days after maize planting, K1=at first weeding (42 days after maize planting) and K2=2nd weeding (62 days after maize planting)". Previous results of this trial were reported in the Annual Reports of 1953, 1954, 1955 and 1956. In the long rains, 1957, the times of application of the sulphate of ammonia and superphosphate treatments were split between maize sowing and grass broad casting.

Estimation of treatment effects was by single autoscythe sample cuts of 12 square yards per plot on three dates, i.e. 22nd November, 1956, 25th February, 1957, and 18th/19th June, 1957. The final date represents almost exactly one calendar year from the last date of undersowing (K2 on 13th June, 1956).

TABLE OF RESULTS—LONG TONS FRESH GREENSTUFF PER ACRE

			P0	P1	P2	K0	K1	K2	Mean
N0	..	..	12.60	15.37	17.65	17.98	15.99	11.64	15.21
N1	..	..	16.27	15.76	17.86	19.39	18.73	11.76	16.63
N2	..	..	14.79	16.78	14.19	17.89	16.48	11.40	15.25
Mean	..		14.55	15.97	16.57	18.42	17.07	11.60	15.7

			K0	K1	K2
P0	..	..	18.58	15.09	9.99
P1	..	..	18.99	17.26	11.64
P2	..	..	17.68	18.85	13.17

Coefficient of Variation=13.05%

L.S.D. at the 1% level of $t=1.88$
5% level of $t=1.39$ } Between Marginal Means.

L.S.D. at the 1% level of $t=3.24$
5% level of $t=2.40$ } Within the body of the table.

The increase in yield due to 2 cwt./acre double superphosphate is significant at $P=0.01$. The increase due to the lower rate is significant at $P=0.05$. There is no significant difference between the rates of phosphate.

The third date of sowing yielded significantly less than the first two, significant at $P=0.01$. In view of the rainfall distribution at sowing time this is not surprising. There is no significant difference between the first two sowing dates.

On the "t" test only, 1 cwt. sulphate of ammonia plots outyielded 0 and 2 cwt., significant at $P=0.05$. As the three preceding arable crops have shown responses to sulphate of ammonia, this is probably a valid effect.

The N+P interaction was significant at $P=0.01$. This interaction is most marked when the higher rate of phosphate is combined with the lower rate of nitrogen.

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ANNUAL REPORT OF THE COTTON RESEARCH OFFICER, NYANZA PROVINCE, 1957

Results of the trials planted in 1956 and harvested in 1957 are summarized below.

Date of Planting Trials

Date of planting trials were laid out at Nambare, Adungosis, Mundika, Funyula and Bunyala. There were four dates of planting, each separated by six weeks, the first being on 2nd April and the last on 6th August. These dates cover the period of the main rains and the two months following them. The results of these trials confirmed earlier experimental findings. The April/May plantings were significantly better than those of August and in most cases the June planting as well. It would appear, therefore, that to get optimum yields, cotton should be planted during the main rains. The April/May plantings produced three to four times the yields from August plantings and in most cases twice the June figures.

Variety Trials

District variety trials were planted at Nambare and Adungosis during the 1956 rains and comprised S47, DE715/6, UK51 and UK48. Results show that at Nambare, S47 and UK51 were significantly better than UK48. At Adungosis the yields of S47 and UK51 were significantly higher than DE715/6 and UK48. This is the first trial where DE715/6 has been significantly outyielded by S47.

At Kibos a variety trial comprising S47, DE715/6, UK51 and U.P.A. was planted. Yields were not significantly different.

Manuring Trial

A trial to find the optimum rate of application of farmyard manure on the black clay soil of Kibos was planted in late April, 1956. The treatments were control, 5 tons/acre, 10 tons/acre, 20 tons/acre, and 40 tons/acre. The results were not significantly different, although the vegetable growths were very different. The heavier the application the better the growth and plant losses increased in the same order with the consequent levelling out of yields. No insecticide was used during this trial and any future repetition of a trial of this type will necessitate some form of stainer (*Dysdercus* spp.) control to get better assessments of productivity of the different treatments.

Field Insecticide Trials

Earlier trials using cotton dust 3:10:0 (3 per cent gamma B.H.C. and 10 per cent D.D.T.) showed that good control of stainers (mainly *Dysdercus nigrofasciatus* and *D. superstitiosus*) could be achieved on early planted cotton by five applications each of 16 lb. per acre at 10-day intervals starting from the time when plants carried two bolls. Experimental evidence has shown over a number of seasons that early planting is a prerequisite for good yields and, in Central and South Nyanza, protection against stainers is essential.

While 3:10:0 cotton dust is known to give good stainer control this dust is costly, and means to reduce expense had to be considered. The three dusts tried were 10 per cent D.D.T., 5 per cent Crude B.H.C., 10 per cent D.D.T., and 3 per

cent gamma B.H.C. 10 per cent D.D.T. The prices for these insecticides in the order given above were 80½, 83 and 106 cents per lb. These dusts were applied at three different rates as follows:—

- (1) Five applications of 16 lb./acre at 10-day intervals. (80.)
- (2) Seven applications of 10 lb./acre at 7-day intervals. (70.)
- (3) Four applications of 16 lb./acre at 12-day intervals. (64.)

The costs per acre are as follows:—

- (1) 3:10:0 cotton dust

Treatment—

- (1) 84.80.
- (2) 74.20.
- (3) 67.84.

- (2) 5 per cent Crude B.H.C. 10 per cent D.D.T.

Treatment—

- (1) 66.40.
- (2) 58.10.
- (3) 53.12.

- (3) 10 per cent D.D.T.

Treatment—

- (1) 64.40.
- (2) 56.35.
- (3) 51.52.

The procedure in this experiment was to have, at selected sites in Central and South Nyanza, ten peasant cotton *shambas*, early planted, and in fairly close proximity. One of the above treatments was applied to each of nine *shambas* and the tenth was used as control. In all, there were some 350 *shambas*, large numbers of which were likely to be discarded for varying reasons. From the results from 100 *shambas* in South Nyanza the following tables were constructed:—

TABLE I—YIELD IN LB. SEED COTTON/ACRE

	10% DDT	10% DDT 5% Crude BHC	3 : 10 : 0 cotton dust
5 Dustings at 10 day intervals ..	499.3	517.5	662.5
7 Dustings at 7 day intervals ..	610.1	525.2	611.9
4 Dustings at 12 day intervals ..	548.7	540.3	687.4

Control 407.0

TABLE 2—VALUE OF CROP LESS COST OF DUST IN SH.

	10% DDT	10% DDT 5% Crude BHC	3 : 10 : 0 cotton dust
5 Dustings at 10 day intervals ..	200.53	203.34	262.03
7 Dustings at 7 day intervals ..	264.91	217.33	246.02
4 Dustings at 12 day intervals ..	229.08	232.90	297.06
Control 193.39			

TABLE 3—PERCENTAGE B GRADE COTTON

	10% DDT	10% DDT 5% Crude BHC	3 : 10 : 0 cotton dust
5 Dustings at 10 day intervals ..	11.3	13.9	13.3
7 Dustings at 7 day intervals ..	12.4	13.0	13.3
4 Dustings at 12 day intervals ..	16.7	11.6	11.2

Control 27.1% B grade

From the data in tables 1, 2 and 3 it is apparent that the dusts used did produce improved yields which more than paid the cost of the dusts and that the percentage of B grade cotton was, in most cases, cut by half as compared to the control. In most cases the increased return is hardly worth the effort of applying the dust while in others the increase is around Sh. 70 to Sh. 100 per acre. For consistently better returns, 3:10:0 cotton dust would appear to be the best.

TABLE 4—DISTRIBUTION OF SHAMBA SIZE IN THIS EXPERIMENT

SHAMBA SIZE	No.
Over 0.1 acre and under 0.2 acre	17
Over 0.2 acre and under 0.3 acre	40
Over 0.3 acre and under 0.4 acre	22
Over 0.4 acre and under 0.5 acre	11
Over 0.5 acre and under 0.6 acre	4
Over 0.7 acre and under 0.8 acre	5
Over 1 acre	1
Total	100

The *shambas* used in this experiment were chosen after they had been planted to cotton. From Table 4, if these plots can be taken as representative of South Nyanza, it would appear that 90 per cent of the *shambas* are under 0.5 acres and that over 50 per cent are under 0.3 acres. In the light of this assessment, most of the improved cash returns given in Table 2 would not look particularly large to the average grower if he planted early. It is interesting to compare the results of this experiment with the total crop of South Nyanza grown in the same season. The untreated early planted control of the experiment yielded 407 lb. seed cotton of which 27 per cent was stained. The average yield for the whole of the South Nyanza cotton area was 87.5 lb. per acre of which

13.5 per cent was stained. It is probable that as the yields were so low the growers could not be bothered to pick all the B grade so that the true percentage would be slightly higher.

Last season in South Nyanza was a particularly poor one due to poor rains. With better standards of cultivation and manuring it is likely that the difference between dusted and undusted cotton would be considerably greater. To get a good cotton crop it must be planted early. The effect of early planting also increases insect damage and protection of some sort is essential.

TABLE 5—COTTON SEED DUSTING TRIAL, KIBOS

TREATMENT	No. of Plants Brairdred by seven weeks	No. which had died by seven weeks	No. of Survivors	% Bacterial Blight Infection of Survivors
Control	112	6	106	18.9
Cuprokyt (50% Cr.) ..	63	5	58	12.1
Perenox (50% Cr.) ..	60	3	57	5.3
Perecot '45 (45% Cr.) ..	80	7	73	2.7
(1) Murphy (45% Cr.) ..	68	4	64	9.4
Murphy (45% Cr.) ..	102	5	97	7.4
Cuprosana (30% Cr.) ..	87	5	82	Nil
Cuprosana (40% Cr.) ..	87	4	83	2.4
(1) Spergon	83	9	74	Nil
Spergon	85	17	68	Nil
Armasan	117	8	109	5.5
Agrosan	66	5	61	6.6
YF.3225	75	1	74	8.1
P.398	91	2	89	1.1
R.1214X22	69	14	55	10.9
R.1214X78	93	1	92	4.3
R.1489X32	104	7	97	3.1
R.3067X23	67	2	65	1.5

This trial was carried out under rainfall conditions supplemented by irrigation. The object was to test various commercial and experimental anti-bacterial blight (*Xanthomonas malvacearum*) seed dressings. There were four randomized blocks of miniature plots, 5 ft. × 6 ft., two rows 3 ft. apart, holes 1 ft. apart, and four seeds per hole. For each treatment a total of 160 seeds were planted. Dusting rates were one part to 300 parts seed by weight except where marked (1) where rate was 1 part to 200.

From Table 5 it can be seen that the number of seedlings which appeared above ground never exceeded 73.1 per cent of the seed planted. Seven treatments produced less than 50 per cent and ten treatments produced less than 50 per cent survivors out of the 160 seeds at seven weeks.

Bacterial blight infection among the survivors was, on the whole, too high to keep this disease in check later in the season. Spergon and Cuprosana were the only treatments which, at seven weeks, produced no seedling infection. With the exception of Cuprosana it appears that the greater the concentration of copper the lower is the number of survivors.

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